# Safety At Heights:
# An Awareness Briefing

Presented at the

## Communications
## Academy
## 2005

Shoreline Conference Center

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www.commacademy.org

# Caveat

- THIS BRIEFING IS *NOT* INTENDED AS TRAINING OR CERTIFICATION OF ANY SORT.
- IT IS INTENDED SOLELY TO PROVIDE SAFETY AWARENESS TO INDIVIDUALS WHO MAY BE CONSIDERING WORK-AT-HEIGHTS

# Briefing Purpose

- Identify and resolve fall hazards
  - work procedures
- Select appropriate fall protection equipment
- Safely inspect fall protection equipment
- Not in this course:
  - Rescue procedures, advanced climbing techniques, hands-on work examples, rappelling, high angle rope work, etc.

# Overview

- Personal Responsibilities
- Background of Fall Hazards
- Regulations (Applicable to Work)
- Fall Hazard Identification
- Hierarchy of Controls
- Hazard Elimination
- Fall Prevention

# Course Overview

- Fall Protection
- Personal Fall Arrest Systems
- Equipment Selection
- Fall Clearances
- Deceleration Distances
- Arresting Forces
- Anchor Points
- Administrative Techniques
- Rescue Methods

# Course Overview

- Equipment Inspection
- Fall Hazard Resolution Example

# Definition of a Competent Person – (OSHA) Applies to Industry

"Competent person" means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and **who has authorization to take prompt corrective measures to eliminate them**.

# Responsibilities of a Competent Person

- Provide project (or program) oversight
- Identify fall hazards
- Resolve fall hazards
- Select fall protection equipment
- Inspect fall protection equipment

# What is a Fall Hazard?

- Types of Fall Hazards:
  - Falls to a lower level
  - Falls to the same level
  - Falls to a higher level
  - Slips
  - Trips

# What Are Fall Considerations?

Anchor points

Fall distance

Rescue/Retrieval

Fall path

Swing fall

Correct harness (personal fall arrest system) wearing/ use

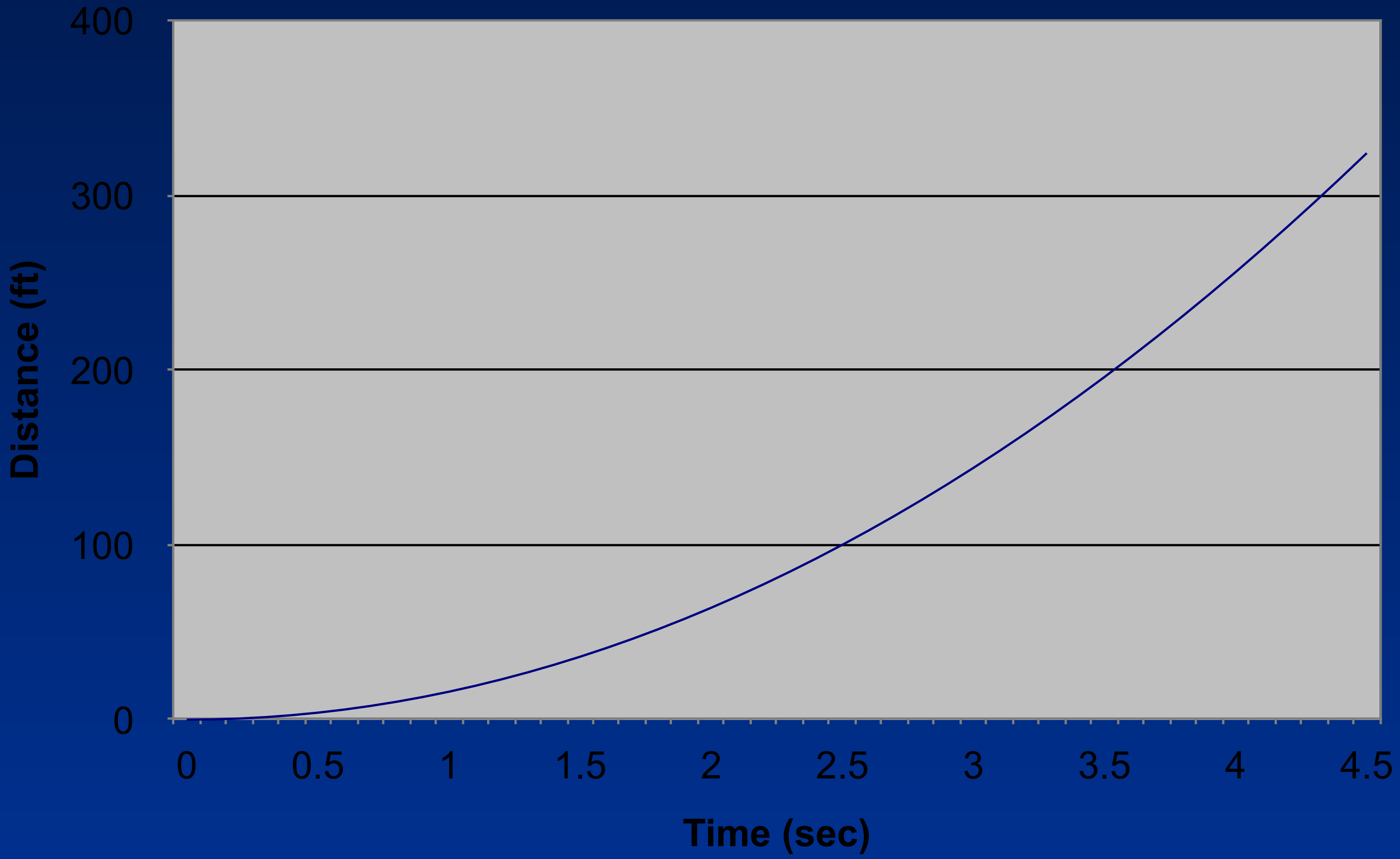
Suspension time

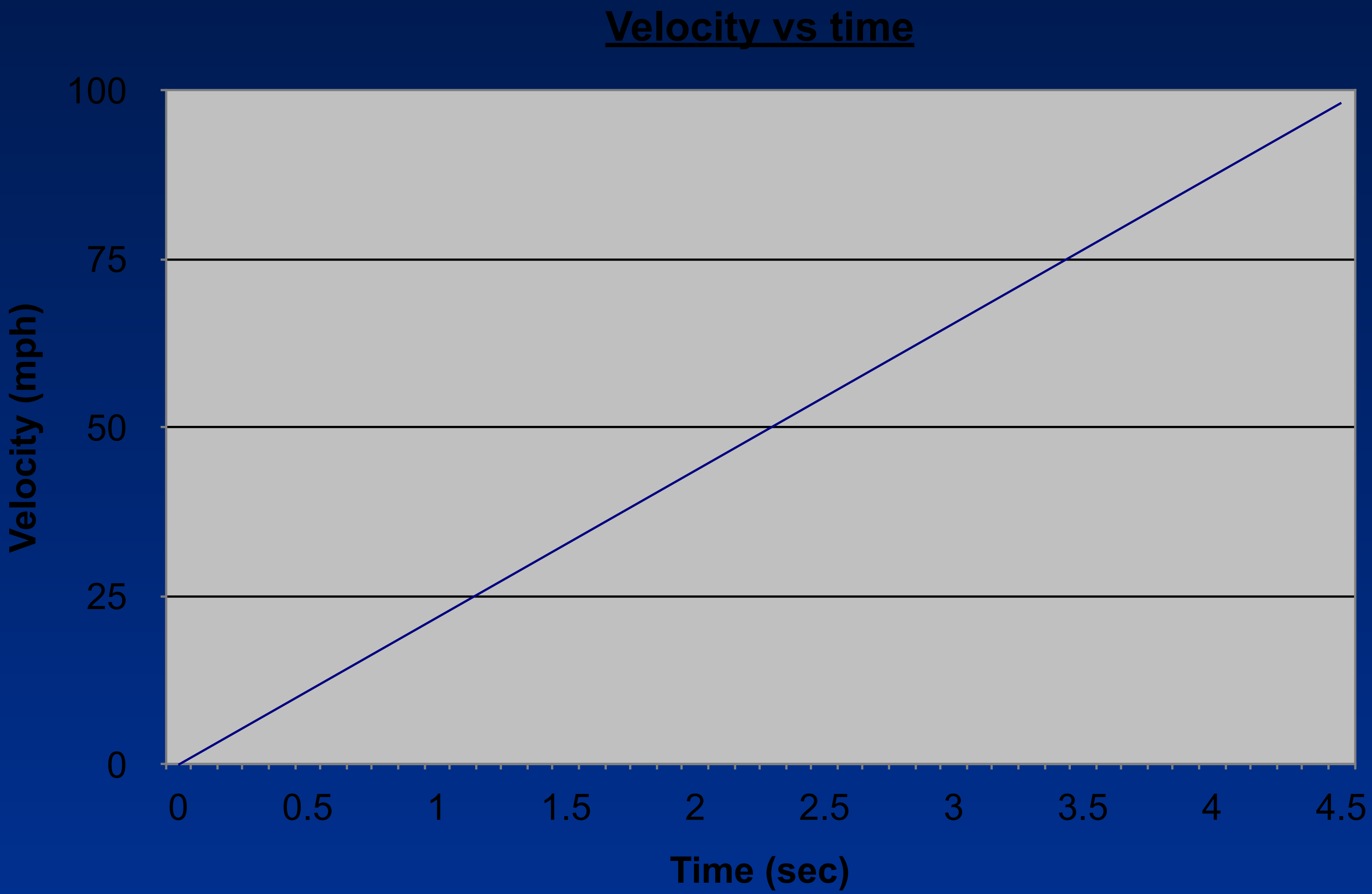
Death and disability and injuries

# What Happens in a Fall with a 6 ft lanyard?

| | | | | | Impact Force (pounds) | |
|---|---|---|---|---|---|---|
| Time (sec.) | Fall Distance | Speed (ft/sec) | Speed (MPH) | Worker Response | Hitting ground | Hitting cross member |
| 0.0 | 0 | 0 | 0 | | 0 | 0 |
| 0.1 | 2" | 3 | 2 | Aware | 21 | 128 |
| 0.2 | 8" | 6 | 4 | | 85 | 512 |
| 0.3 | 1' 5" | 10 | 7 | Reflex | 192 | 1152 |
| 0.4 | 2' 7" | 13 | 9 | Start to Move | 341 | 2048 |
| 0.5 | 4' | 16 | 11 | | 533 | 3200 |
| 0.6 | 5' 9" | 19 | 13 | Slight Movement | 768 | 4608 |
| 0.61 | 6' | 20 | 13 | Lanyard activates | | |
| 0.7 | 7' 10" | 22 | 15 | | 1045 | 6272 |
| 0.8 | 10' 3" | 26 | 17 | | 1365 | 8192 |
| 0.9 | 13' | 29 | 20 | | 1728 | 10368 |
| 1.0 | 16' | 32 | 22 | | 2133 | 12800 |

# Fall distance vs Time




Velocity vs time
Velocity (mph)
100
75
50
25
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Time (sec)

# Why Be Concerned?

- 49 to 468 deaths per 100,000 tower workers; 5 deaths per 100,000 for all US industries
- What are the typical failures?
  - People don’t use PPE
  - Wrong PPE selected
  - Improper equipment use
  - Equipment failure

- Other student experiences?

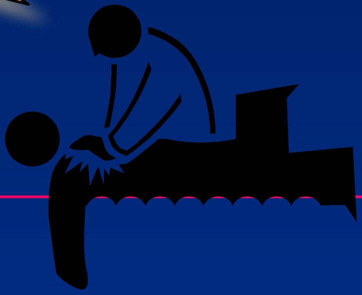
# Cost of Fall Protection

- Study by a Fortune 50 company
  - initial design change = $1
  - final design change = $100
  - fix after installation = $1000
  - fix after accident = $10,000 (including production downtime)
- On average, you lose 30+ days due to a fall injury - more than any other type of injury

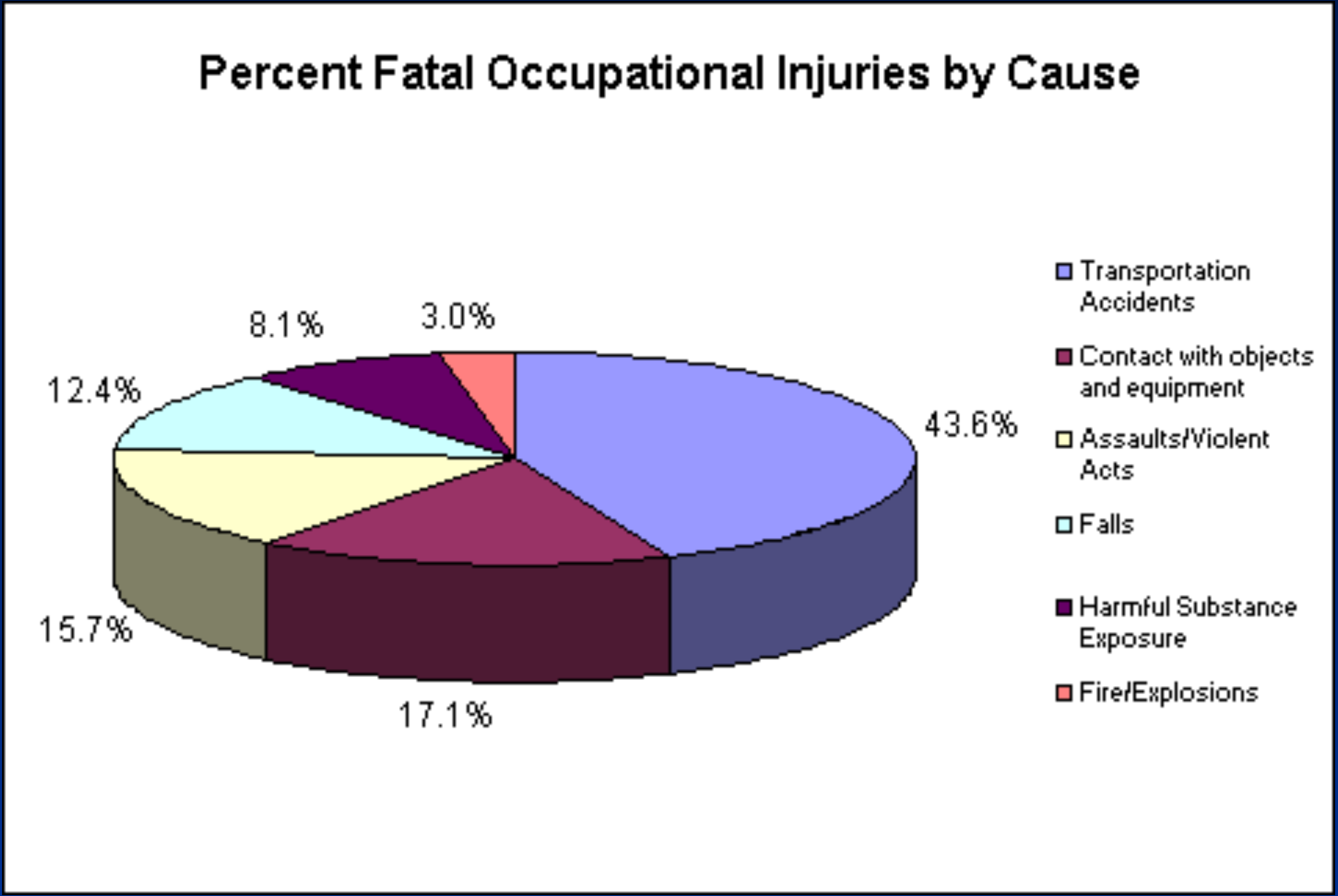
# How High Can You Go Before Being Concerned About Falling?

| Height |
|---|
| 1.0 m |
| 2.0 m |
| 2.5 m |
| 3.0 m |
| 3.5 m |
| 4.0 m |
| > 4.0 m |

85% of people who fall from > 3.4 m (11 ft) die …..



# National Statistics



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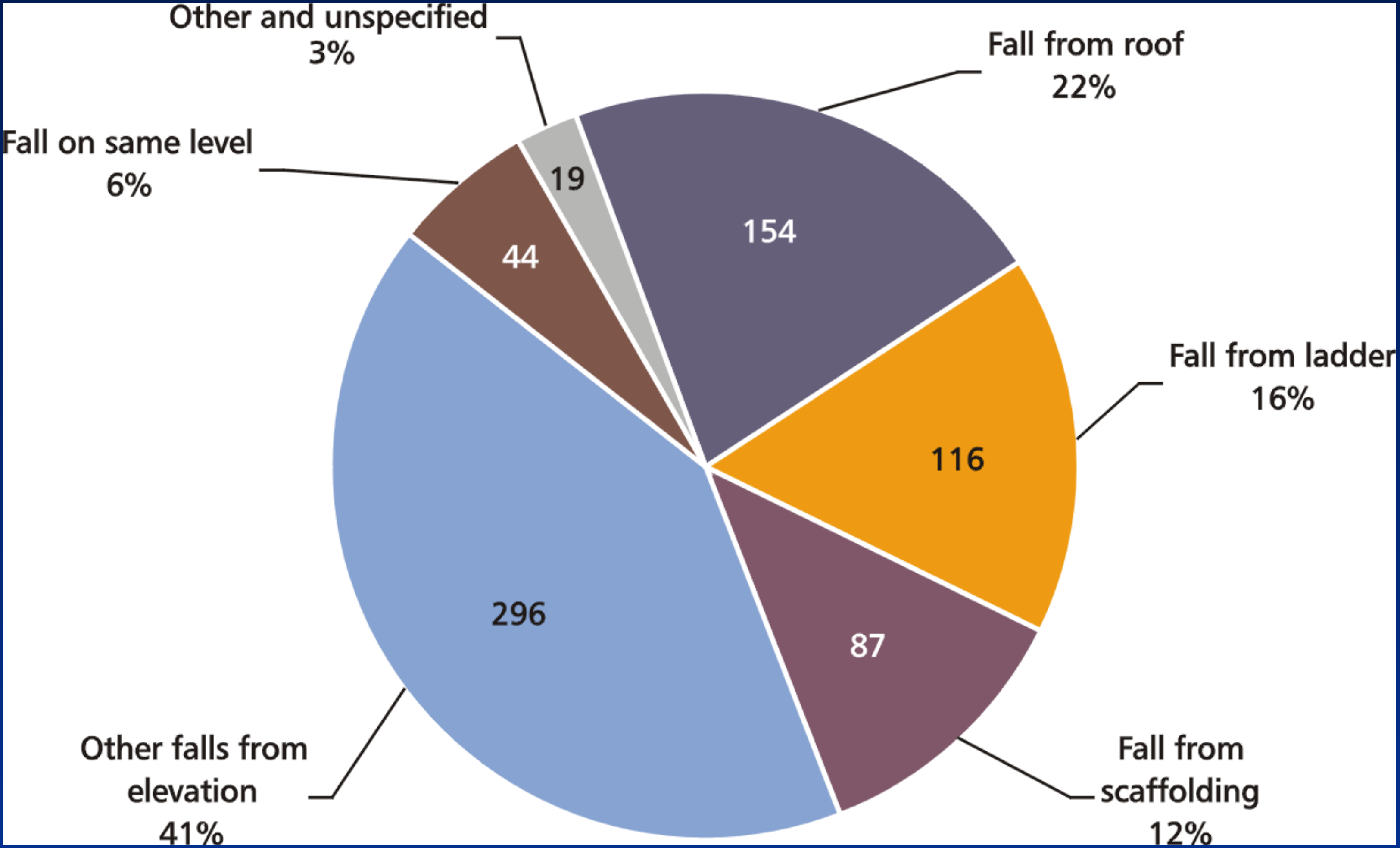

# OSHA Regulations

- OSHA (Occupational Safety and Health Administration)
  - Legal requirements for workplace safety
- General Industry (29 CFR 1910)
  - Applicable during routine maintenance and testing
- Construction Industry (29 CFR 1926)
  - Applicable during construction, alteration and/or repair, including painting and decorating

# General Industry OSHA

- SubPart D: Walking-Working Surfaces
  - 1910.22: General requirements
  - 1910.23: Guarding floor and wall openings and holes
  - 1910.24: Fixed industrial stairs
  - 1910.25: Portable wood ladders
  - 1910.26: Portable metal ladders
  - 1910.27: Fixed ladders
  - 1910.28: Safety requirements for scaffolding
  - 1910.29: Manually propelled mobile ladder stands and scaffolds
  - 1910.30: Other working surfaces

# General Industry OSHA

- SubPart R: Telecommunication Standard
  - Applicable when working on telecommunication equipment

# Construction OSHA

- SubPart M: Fall Protection
  - Fall Protection System Selection
  - Definition of Hazardous Locations
  - Fall Protection System Requirements
  - Protection from Falling Hazards
  - Exemptions
- SubPart X: Stairways and Ladders
  - 1926.1053: Ladders

# Fall Hazard Analysis

- Evaluate the hazard *before* finding a solution.
- Use Hazard or Risk Prediction -- What are the conditions and behaviors to consider?
  - How will we get to the work area?
  - What are the hazards below the work area?
  - How high is the work area?
  - Are there holes or openings below or around the work area?
  - Are there slip or trip hazards around the work area?
  - How difficult is it to rescue someone if they fall?

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Adapted for CFR 1926/1910 OSHA Reg's

# FALL PROTECTION PLANNING MATRIX

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- This matrix provides general guidance only. It must be only be used by trained and competent persons who have knowledge of the precise requirements of the applicable legislation. This form guides planning of fall protection ONLY - protective equipment and procedures for other types of hazards must also be in place.
- TO USE: Proceed clockwise - record all required details. Blacken at least one circle (from each number or letter series) at each corner to choose the system or options. Each series of circles is prioritized ("1" or "a" or "i" is the best choice). Solid Bullets are mandatory.

## Step I: Assess the Fall Hazard

☐ Greater than 6 ft. above Lower Safe Level Height: ft.
☐ Landing Hazard: (Machinery, Liquids, Debris, Chemicals)

## Step II: Select a Secondary (Backup) System

| | Eliminate the Hazard or the Reason for Being There | Traditional Fall Protection: (Guardrails/Ladder Cages/Slide Guards) | Floor/Hole/Hatch Cover: (Secured in Place, Marked) | Fall Restraint System: (Harness/Belt, Lanyard/Lifeline & Anchorage) | Fall Arrest System: ☐ Direct Coupled to Anchor (Lanyard) | ☐ Ladder Climbing System (Work Positioning | ☐ SRL System when free Fall < 2 ft) | ☐ Vertical Lifeline System | ☐ Horizontal Rigid Rail System | ☐ Permanent Horizontal Lifeline System | ☐ Temporary Horizontal Lifeline System | ☐ Safety Nets | ☐ Lead Climbing Techniques (2 Person) | Fall Protection Plan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ☐ **Open Sides:** ☐ Floors or Platforms ☐ Stairs ☐ Catwalks ☐ Scaffolds ☐ Unguarded Machinery | ① | ② | | ③ | ④ | | ⑤ | ⑥ | | ⑦ | ⑧ | ⑨ | | |
| ☐ **Wall Openings:** at Least 30 in. High x 18 in. Wide and Less Than 3 ft. above the Working Surface | ① | ② | | ③ | ④ | | ⑤ | ⑥ | | ⑦ | ⑧ | ⑨ | | |
| ☐ **Floor Openings:** at Least 12 inches in any dimension: ☐ Hatchway ☐ Manhole ☐ Pit ☐ Tank ☐ Shaft ☐ Skylight | ① | ③ | ② | ④ | ⑤ | | ⑥ | ⑦ | | | | | | |
| ☐ **Leaving the Guarded Floor Surface:** of a ☐ Manlift (Any Type) ☐ Scaffold ☐ Catwalk ☐ Platform | ① | | | | ② | | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ | ⑨ | ⑩ |
| ☐ **Working from inside a Properly Guarded Man-lift:** (Scissor, Boom, Bucket, Articulating) | ① | | | ② | ③ | | ④ | | | | | | | |
| ☐ **Working from a Suspended Platform:** ☐ Swing Stage ☐ Manbasket ☐ Boatswain's Chair ☐ Descent Harness | ① | | | | ② | | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ | | |
| ☐ **Fixed Ladder:** ☐ Working with Both hands ☐ Higher than 20 ft.(General Industry) ☐ Higher than 24 ft.(Construction) | ① | | | | | ② | ③ | ④ | | | | ⑤ | ⑥ | |
| ☐ **Portable Ladder:** ☐ Working with Both hands | ① | | | | | | ② | ③ | | | | ④ | | ⑤ |
| ☐ **Working on Roofs Steeper than 4:12 Pitch** | ① | ② | | ③ | | ④ | | ⑤ | ⑥ | | ⑦ | ⑧ | | |
| ☐ **Working Within 6 ft. of a Roof Edge, Less than 4:12 Pitch** | ① | ② | | ③ | | | | | ④ | | ⑤ | ⑥ | | ⑦ |
| ☐ **Structural Climbing:** (Bridge, Roof Truss, Towers, Drilling Rig, Pile Driver) | ① | | | | | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ | ⑨ | ⑩ |
| ☐ **Activities Where Fall Protection Is Deemed Infeasible by a Qualified Person** (Leading Edge Construction Work, etc.) | ① | | | | | | | | | | | | | ● |
| ☐ **Other, Describe:** | ① | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ | ⑨ | ⑩ | ⑪ | ⑫ | ⑬ | ⑭ |

## Step 3: Select/Confirm/Record Details of the Secondary System

| ☐ Inspect all Equipment and Systems Prior to Each Use | ☐ All Persons Have Been Properly Trained and Briefed | ☐ Approved or Installed By a Competent Person | ☐ Designed, Approved and/or Installed by a Qualified Person | | | Eliminate the Hazard or the Reason for Being There | Traditional Fall Protection | Floor/Hole/Hatch Cover | Fall Restraint System | Fall Arrest System: Direct Coupled to Anchor (Lanyard) | Ladder Climbing System | SRL System | Vertical Lifeline System | Horizontal Rigid Rail System | Permanent Horizontal Lifeline System | Temporary Horizontal Lifeline System | Safety Nets | Lead Climbing Techniques (2 Person) | Fall Protection Plan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | ● | ② | ① | **Guardrails:** | (42" ±3" top rail with minimum 200 lb. strength, mid-rail minimum 150 lb. strength) | | ① | | | | | | | | | | | | |
| ● | ● | ② | ① | **Ladder Cages:** | (Landings every 30 ft. in General Industry, 50 ft. in Construction) | | ① | | | | | | | | | | | | |
| ● | ● | ② | ① | **Slide Guards** | (minimum 4" high at roof eave) | | ① | | | | | | | | | | | | |
| ● | ● | ② | ① | **Floor/Hole Hatch covers:** | (2 x Heaviest Worker, Vehicle or other Load, Minimum 200 lbs.) | | | ● | | | | | | | | | | | |
| ● | ● | ② | ① | **Select Anchorage:** | ☐ > 5000 lbs. (Free Fall >2 ft.) Describe: | | | | ① | ① | ① | ① | ① | | | | | | |
| | ● | ② | ① | | ☐ > 3000 lbs. ***(Work Positioning)*** Describe: | | | | ② | ② | ② | ② | ② | | | | | | |
| ● | ● | | ● | | ☐ Strength Factor of Safety> 2 Describe: | | | | | ③ | ③ | ③ | ③ | ● | ● | ● | ● | | |
| ● | ● | ② | ① | | ☐ 4 x intended load, minimum 800 lbs. Describe: | | | | ③ | | | | | | | | | | |
| ● | ● | | | **Body Support:** | ☐ Full Body Harness, Dorsal Attachment to the Fall Arrest System, Except Ladder Climbing Systems | | | | ⓐ | ● | ⓐ | ⓐ | ● | ● | ● | ● | | ● | |
| ● | ● | | | | ☐ Waist Belt ***(WORK POSITIONING OR FALL RESTRAINT ONLY)*** | | | | ⓑ | | ⓑ | ⓑ | | | | | | | |
| | ● | ② | ① | **Estimate Required Clearance:** | ( ft. Free Fall) + ( ft. Lockoff & Deceleration) + 3 ft (Stretch + Buffer) = ft. | | | | | | ● | ● | ● | ● | ● | ● | | | |
| | ● | ② | ① | **Measure Available Clearance:** | ft. ☐ Exceeds Estimated Clearance Requirement (Safe) | | | | | | (i) | (i) | (i) | (i) | (i) | (i) | | | |
| | ● | | ● | | ☐ Less Than Estimated Clearance Requirement (Caution) | | | | | | (ii) | (ii) | (ii) | (ii) | (ii) | (ii) | | | |
| | ● | | ● | **Fall Protection Plan:** | ☐ Written Reasons Why Positive Fall Protection is Infeasible | | | | | | | | | | | | | | ● |
| | ● | | ● | (attach to this document) | ☐ Written Work Procedures Posted (Available at the Worksite) | | | | | | | | | | | | | | ● |
| | ● | | ● | | ☐ Controlled Access Zone Defined by: ☐ Warning Line System ☐ Other: | | | | | | | | | | | | | | ● |
| | ● | | ● | | ☐ Safety Monitor Name or Other Designation: | | | | | | | | | | | | | | ● |
| ● | ● | ● | | **Rescue & Emergency Provisions:** | ☐ Phone Number: ☐ Equipment/Procedures/Personnel On-site | | | | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| ● | ● | ● | | **Emergency Egress System or Plan:** | Details: | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |

## Step IV: Qualifications/Inspections/Approvals

Worksite Location:

Date(s) of Work:

Work Task(s):

Name(s) of Employees Protected by this Plan and Authorized to Execute the Work Task

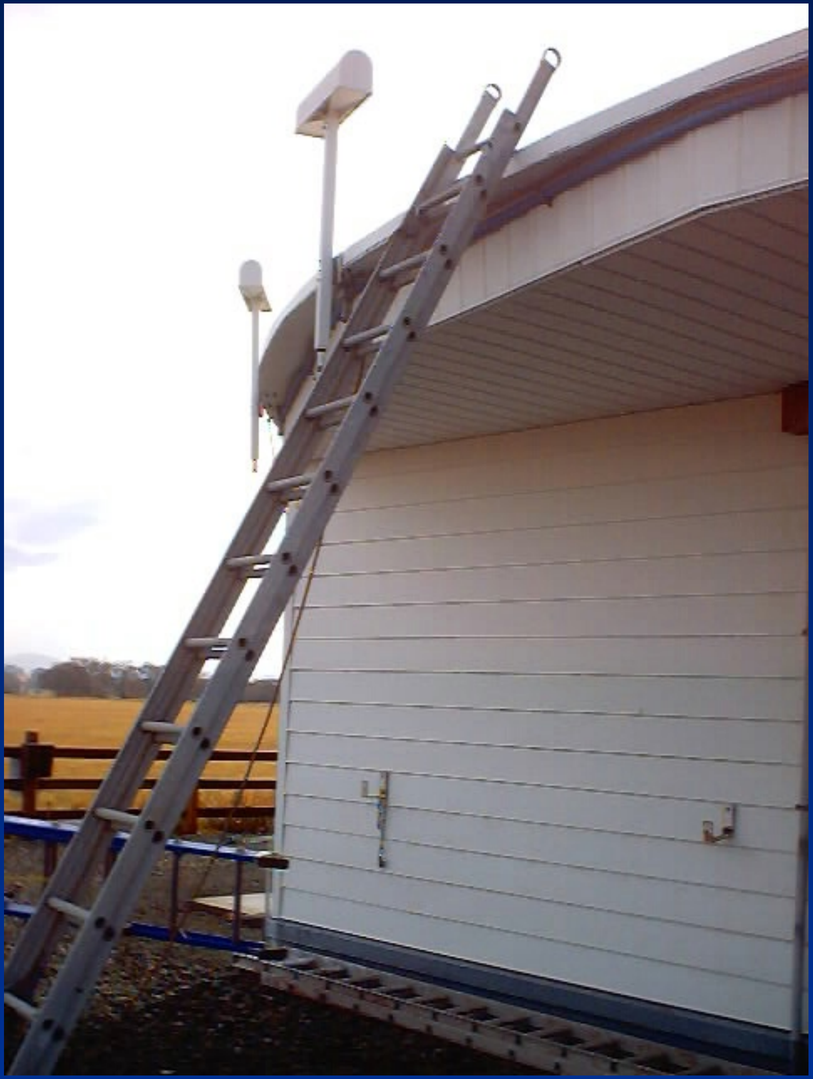
Signature of Competent Person Preparing Plan

**Signature of Qualified Person (if required)** Approving Plan, Systems or Anchors

# Fall Hazards

- Identify and Discuss examples of fall hazards you’ve encountered

# Fall Hazards - Example 1



Ladder does not extend 3’ above the roof

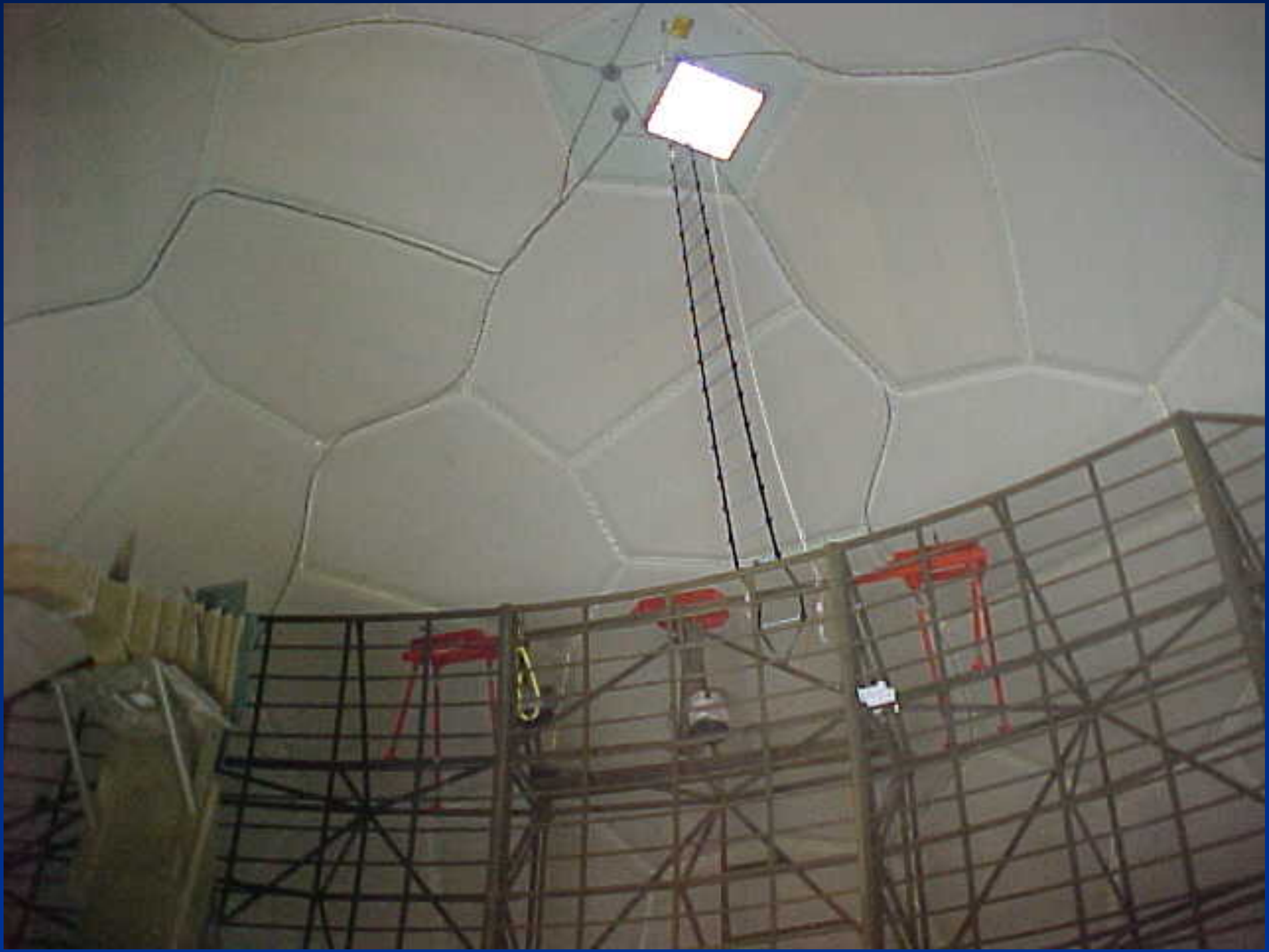
- (no ladder restraint to keep ladder from sliding away from edge)

- no roof protection (especially for monitor antennas)

# Fall Hazards - Example 2

- How to access hatch (no secondary)

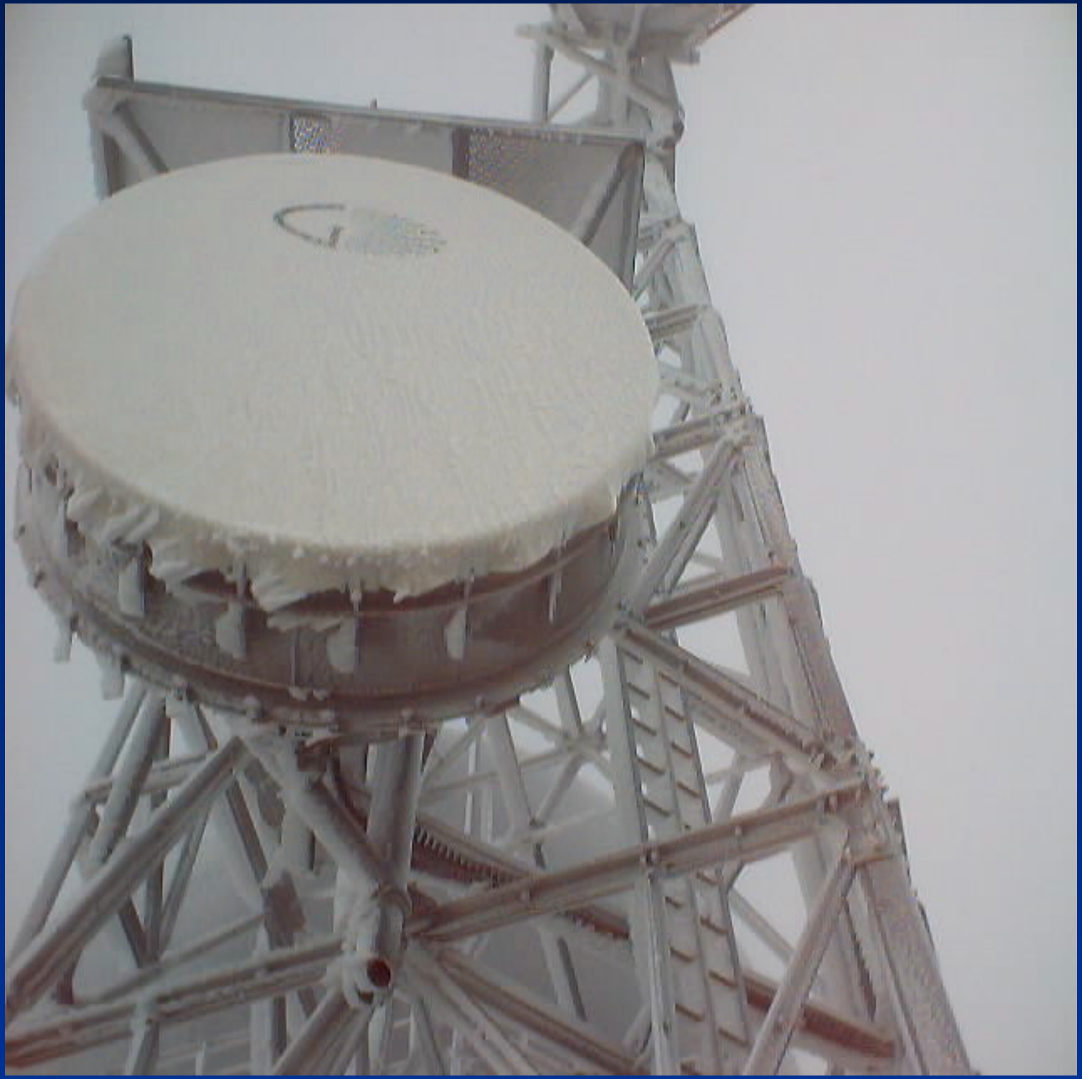
One solution - remove need for obstruction lighting - hazard elimination, will discuss later



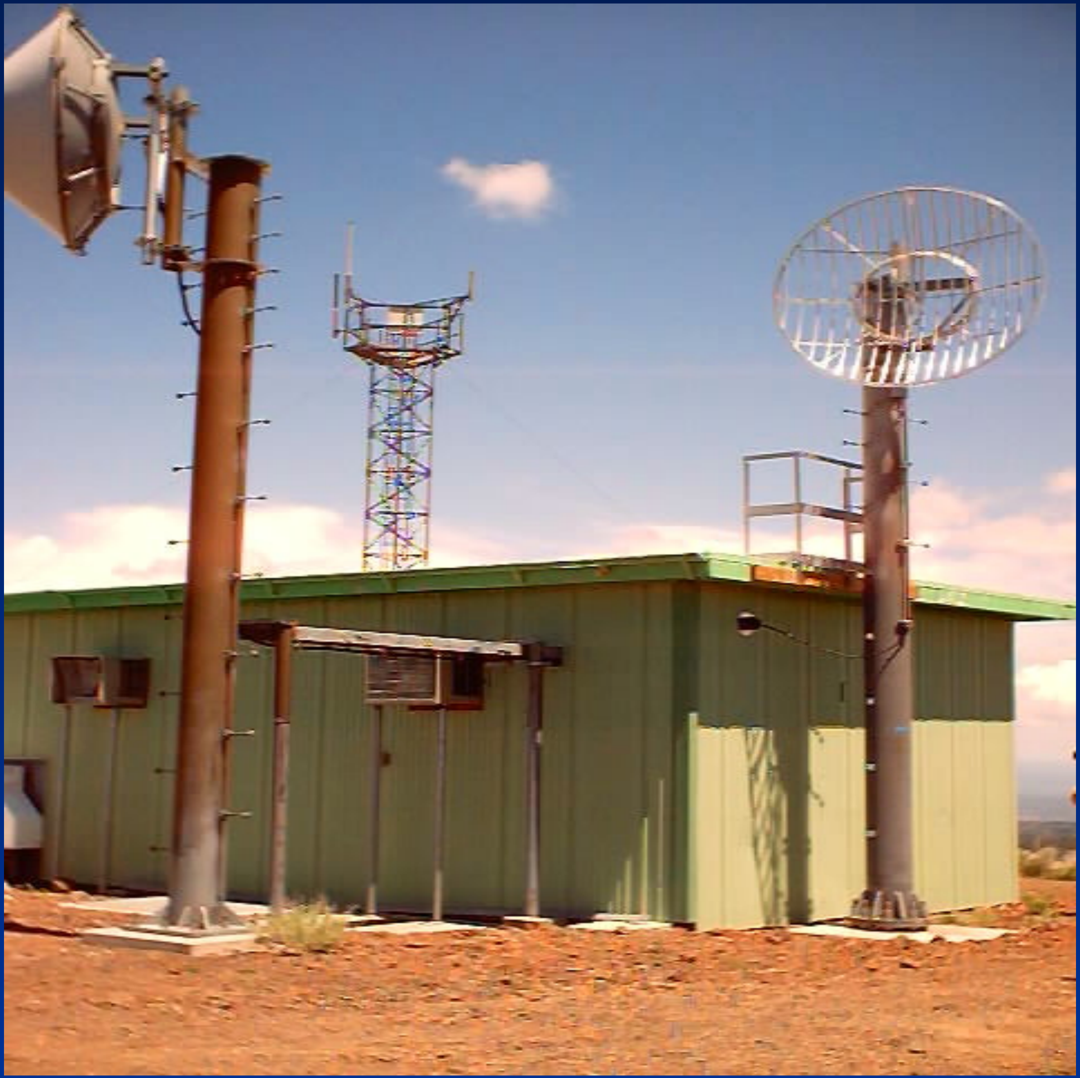
# Fall Hazards - Example 3

- Can't communicate with ground worker, rescue consideration

# Fall Hazards - Example 4



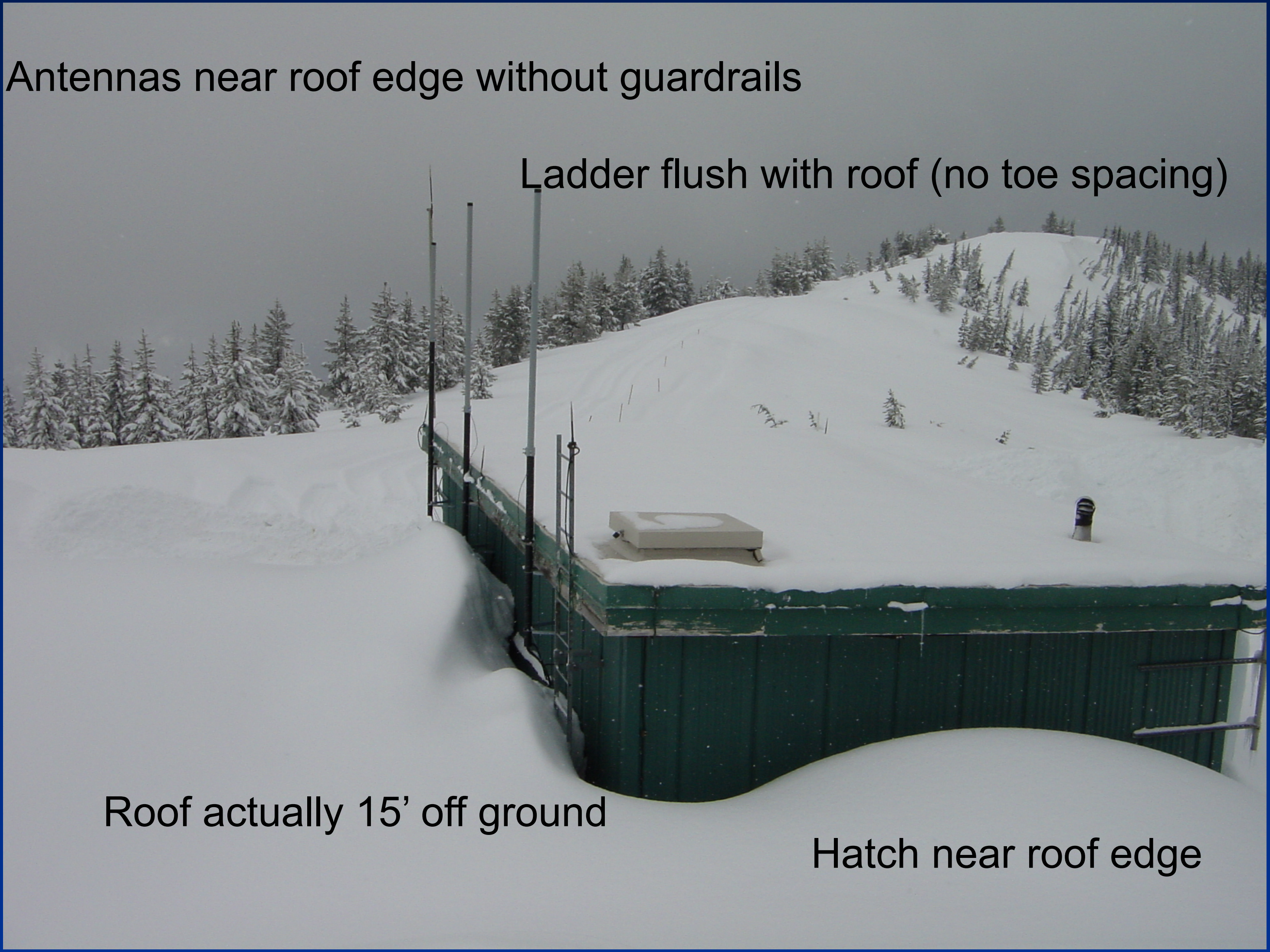
# Fall Hazards - Example 5



- Step bolts, no proper anchor points, no safety climb

# Fall Hazards - Example 6

# Fall Hazards - Example 7



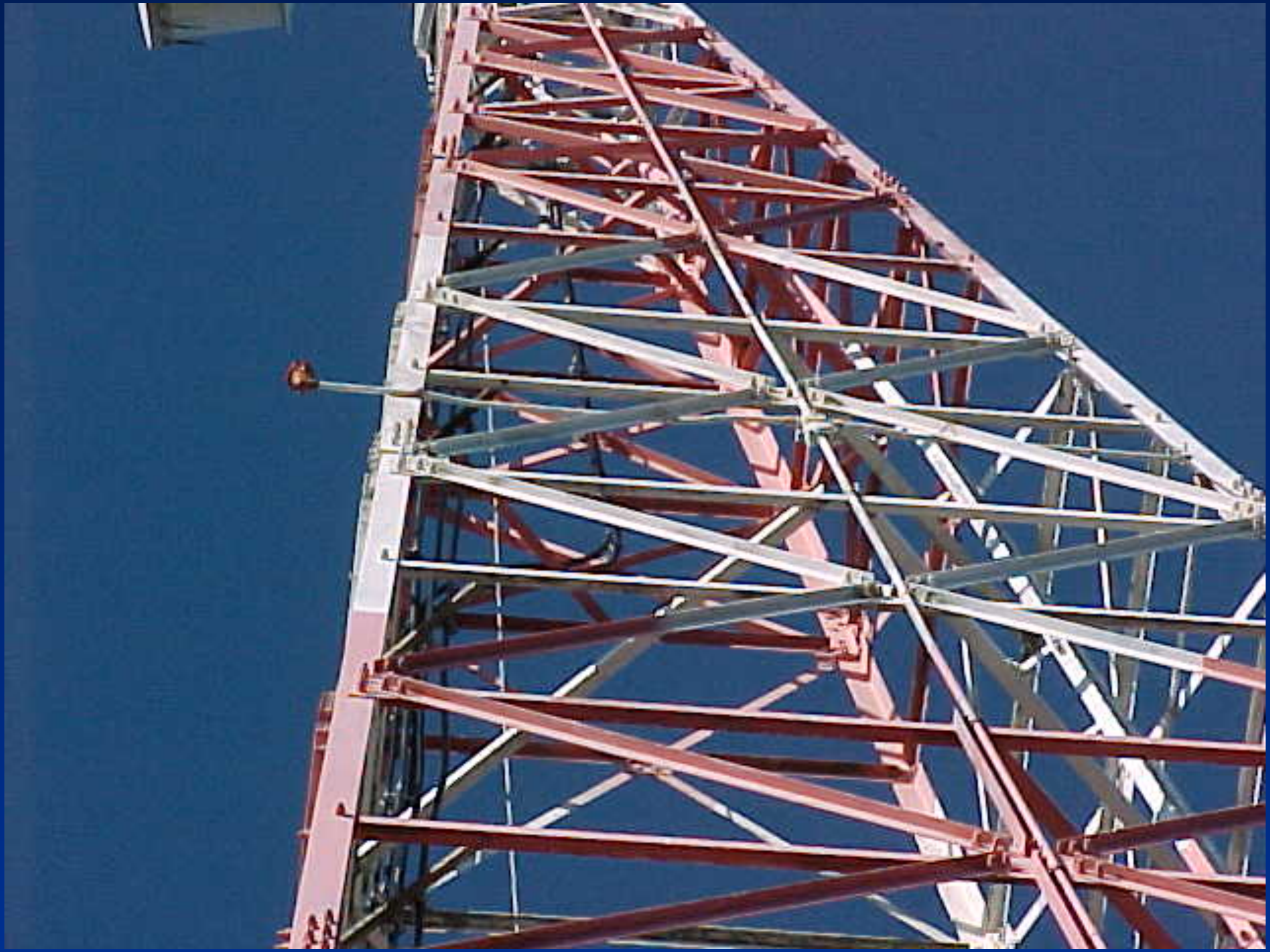
Antennas near roof edge without guardrails

Ladder flush with roof (no toe spacing)

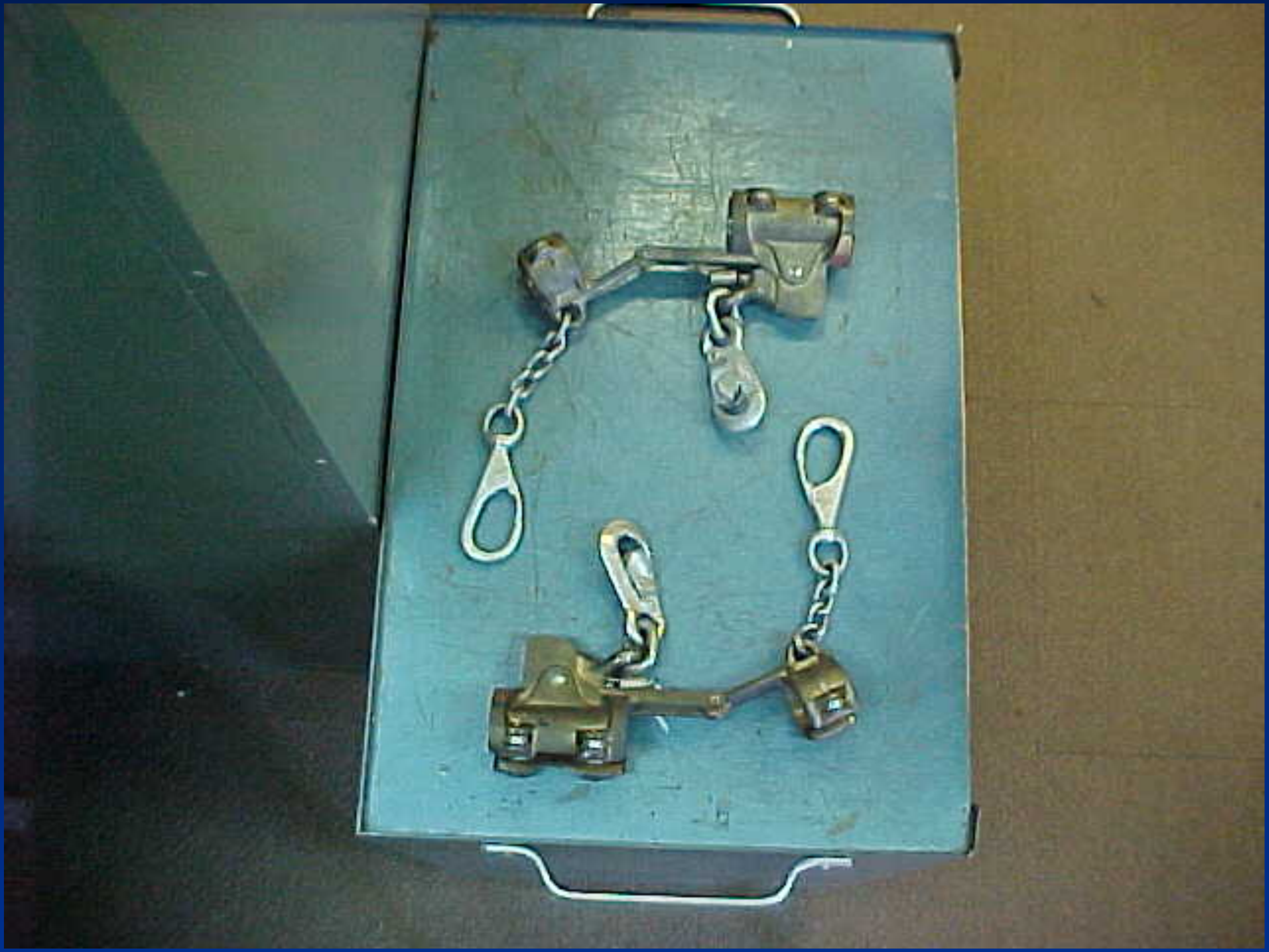
Roof actually 15’ off ground

Hatch near roof edge

# Fall Hazards - Example 8

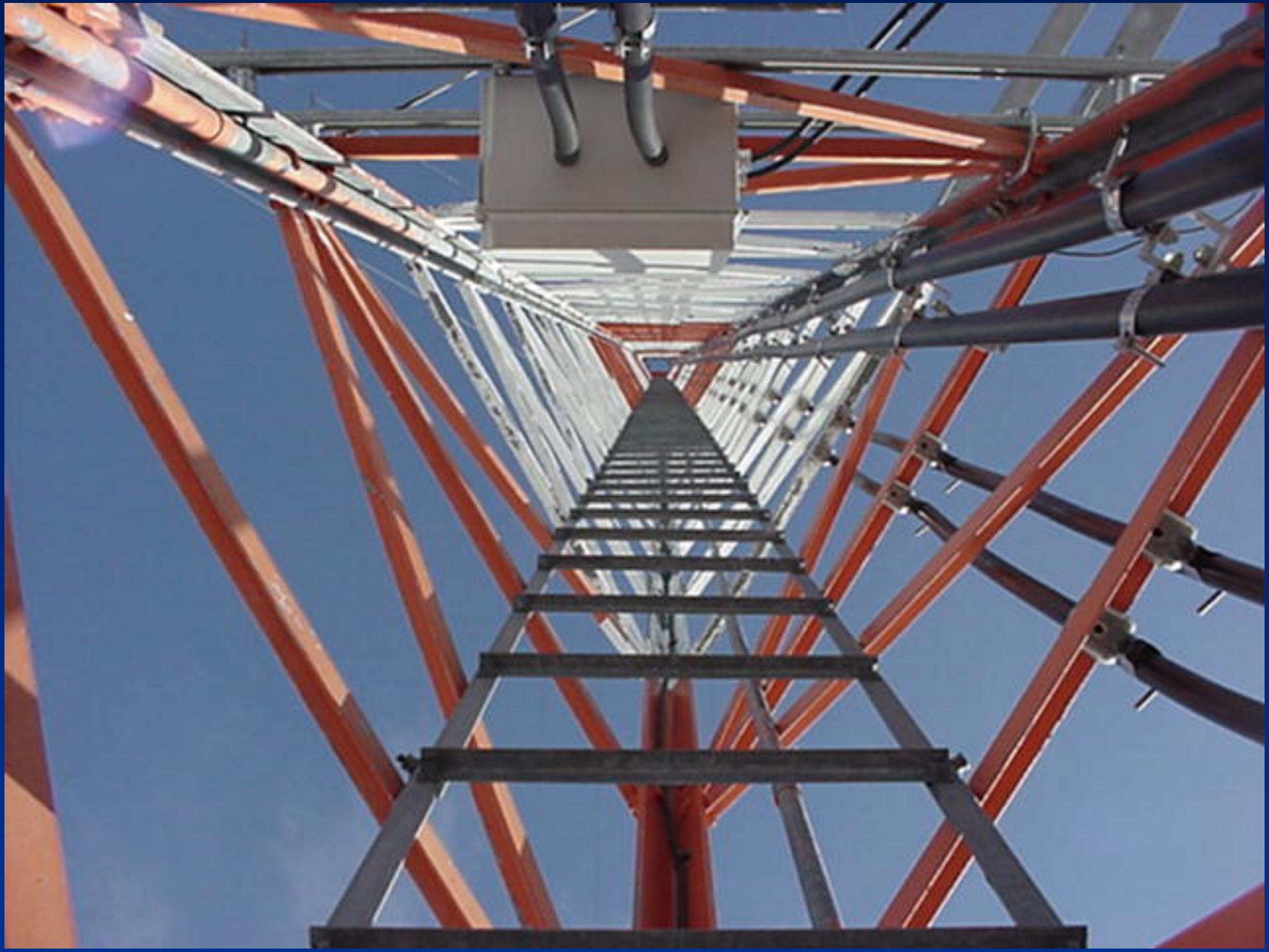


# Fall Hazards - Example 9



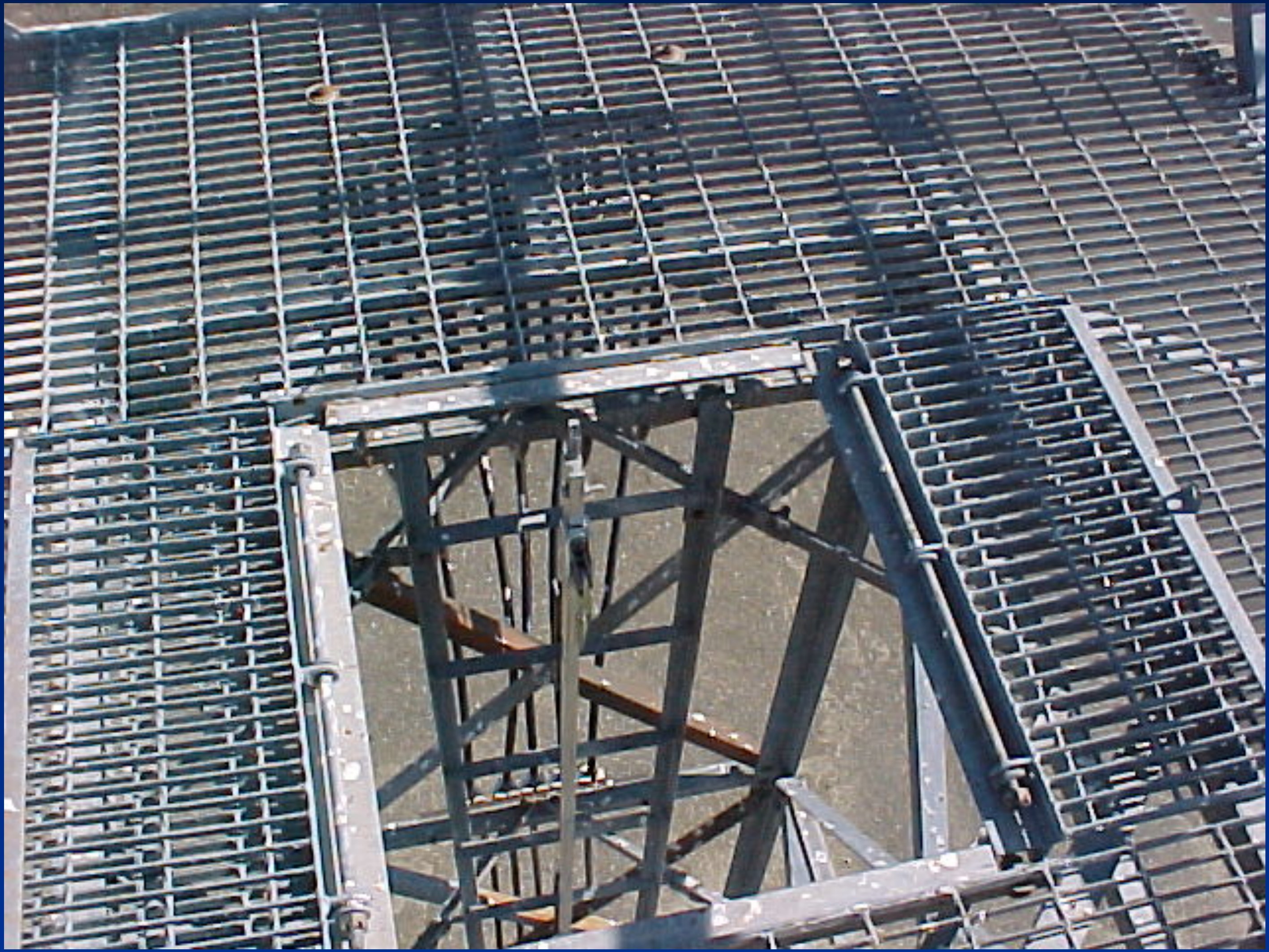
Non-Locking Snaphooks

# Fall Hazards - Example 10



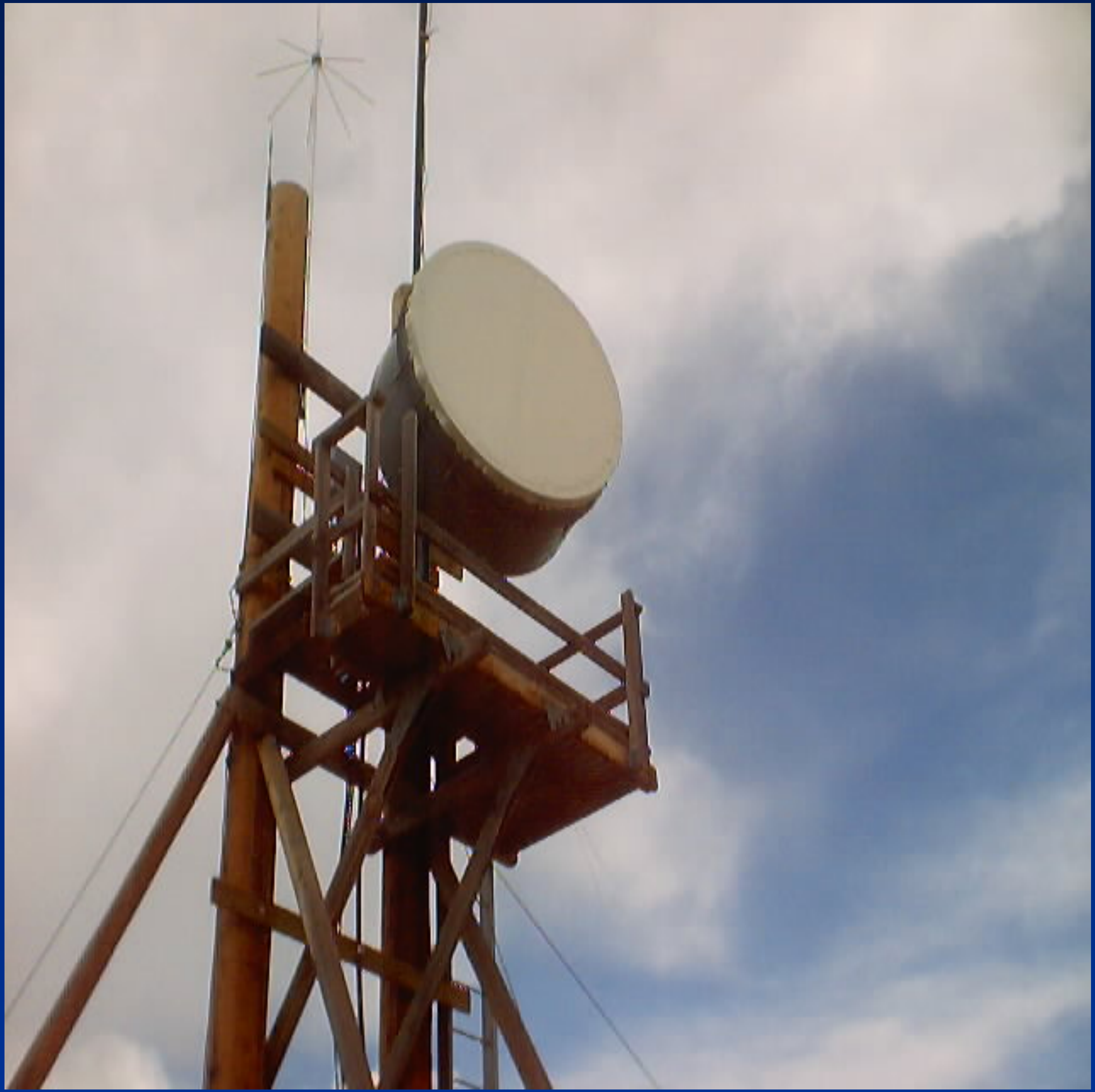
- No ladder safety system

# Fall Hazards - Example 11



- Ladder does not extend 36” above platform

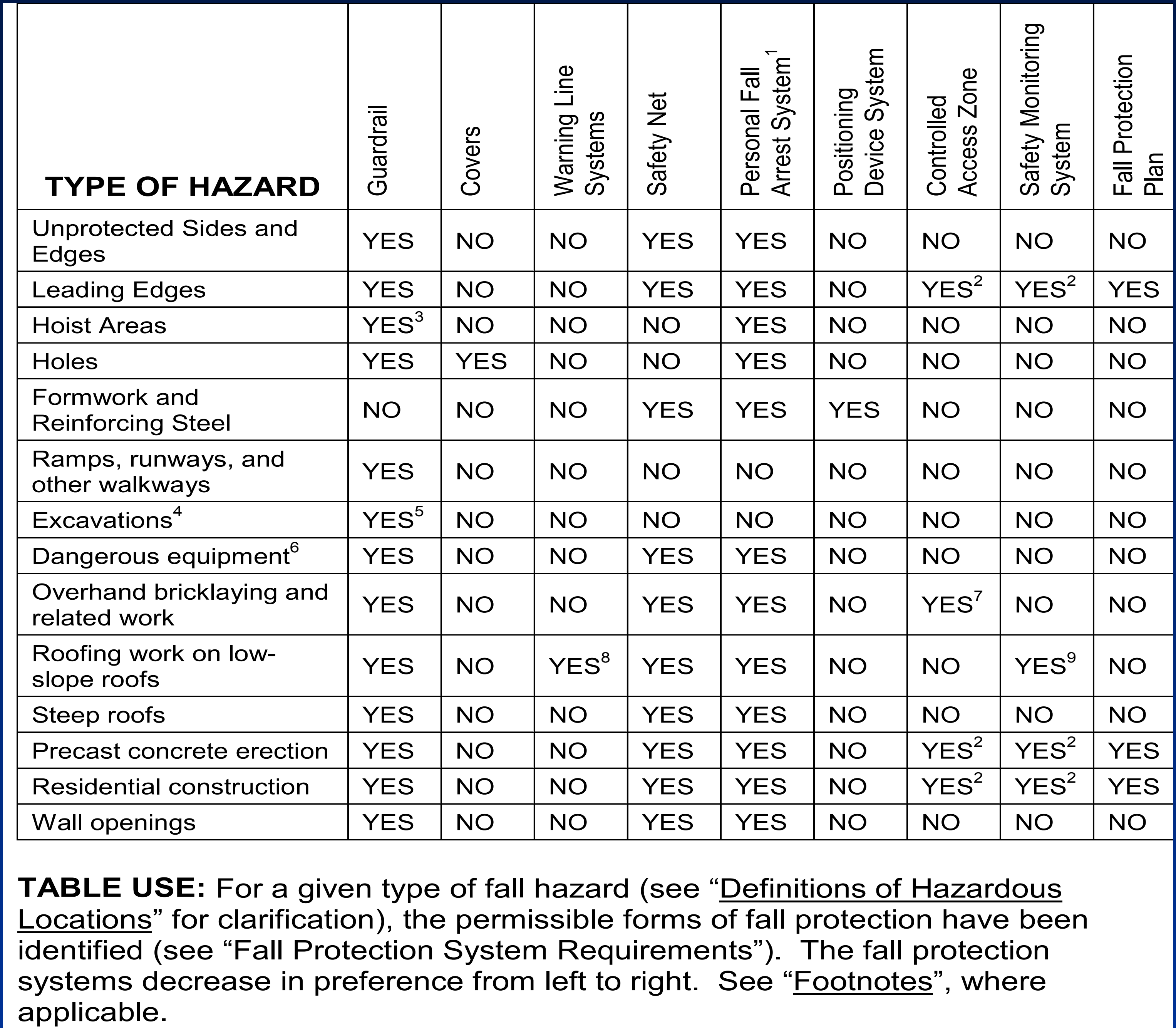
# Fall Hazards - Example 12



- top rail has been removed

# Hierarchy of Controls

- Fall Hazard Elimination
- Fall Hazard Prevention
- Fall Arrest
- Administrative Techniques



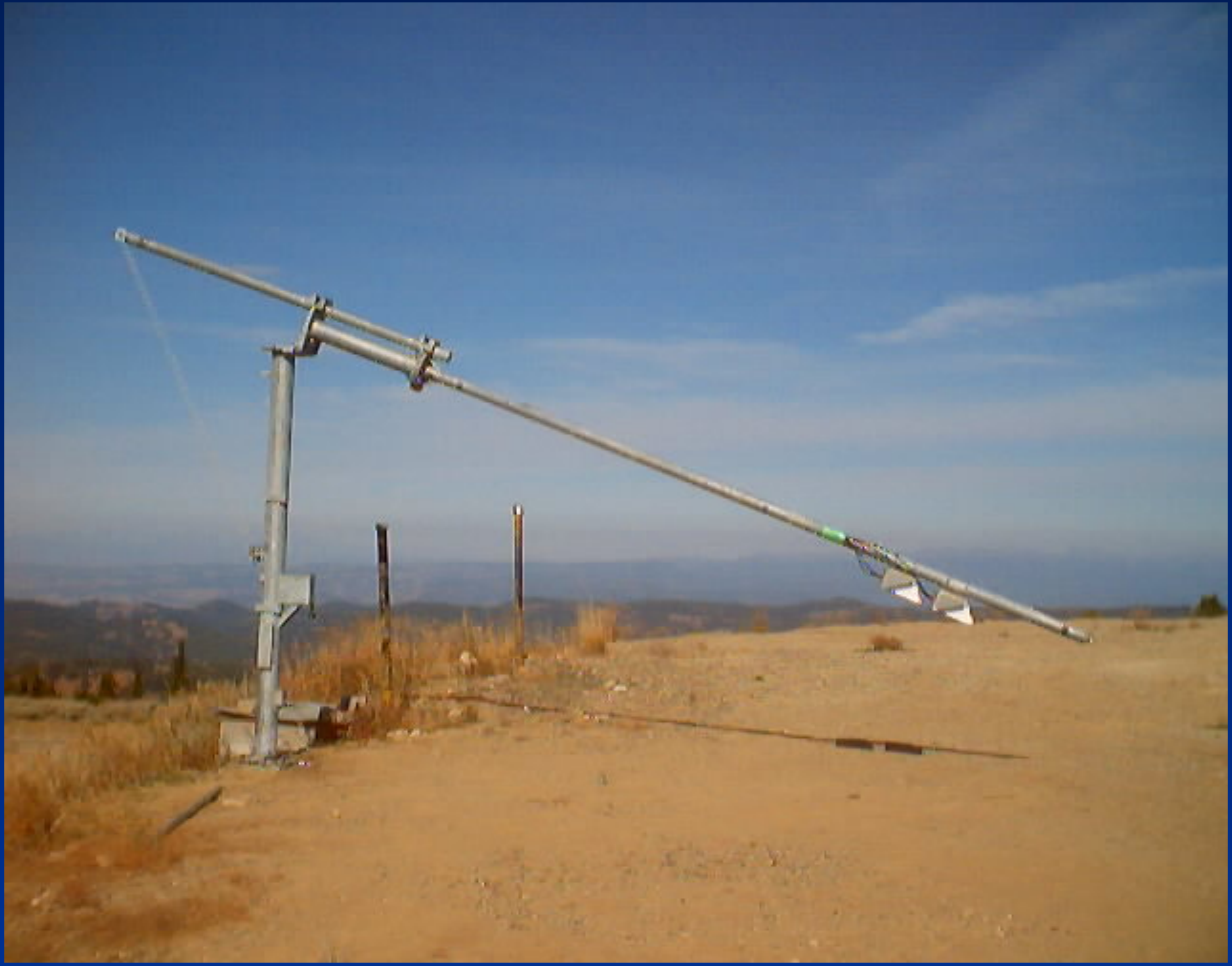
| TYPE OF HAZARD | Guardrail | Covers | Warning Line Systems | Safety Net | Personal Fall Arrest System[1] | Positioning Device System | Controlled Access Zone | Safety Monitoring System | Fall Protection Plan |
|---|---|---|---|---|---|---|---|---|---|
| Unprotected Sides and Edges | YES | NO | NO | YES | YES | NO | NO | NO | NO |
| Leading Edges | YES | NO | NO | YES | YES | NO | YES[2] | YES[2] | YES |
| Hoist Areas | YES[3] | NO | NO | NO | YES | NO | NO | NO | NO |
| Holes | YES | YES | NO | NO | YES | NO | NO | NO | NO |
| Formwork and Reinforcing Steel | NO | NO | NO | YES | YES | YES | NO | NO | NO |
| Ramps, runways, and other walkways | YES | NO | NO | NO | NO | NO | NO | NO | NO |
| Excavations[4] | YES[5] | NO | NO | NO | NO | NO | NO | NO | NO |
| Dangerous equipment[6] | YES | NO | NO | YES | YES | NO | NO | NO | NO |
| Overhand bricklaying and related work | YES | NO | NO | YES | YES | NO | YES[7] | NO | NO |
| Roofing work on low-slope roofs | YES | NO | YES[8] | YES | YES | NO | NO | YES[9] | NO |
| Steep roofs | YES | NO | NO | YES | YES | NO | NO | NO | NO |
| Precast concrete erection | YES | NO | NO | YES | YES | NO | YES[2] | YES[2] | YES |
| Residential construction | YES | NO | NO | YES | YES | NO | YES[2] | YES[2] | YES |
| Wall openings | YES | NO | NO | YES | YES | NO | NO | NO | NO |

**TABLE USE:** For a given type of fall hazard (see "Definitions of Hazardous Locations" for clarification), the permissible forms of fall protection have been identified (see "Fall Protection System Requirements"). The fall protection systems decrease in preference from left to right. See "Footnotes", where applicable.

# Hazard Elimination Systems

# Hazard Elimination Systems

## Tilt-down/crank down towers

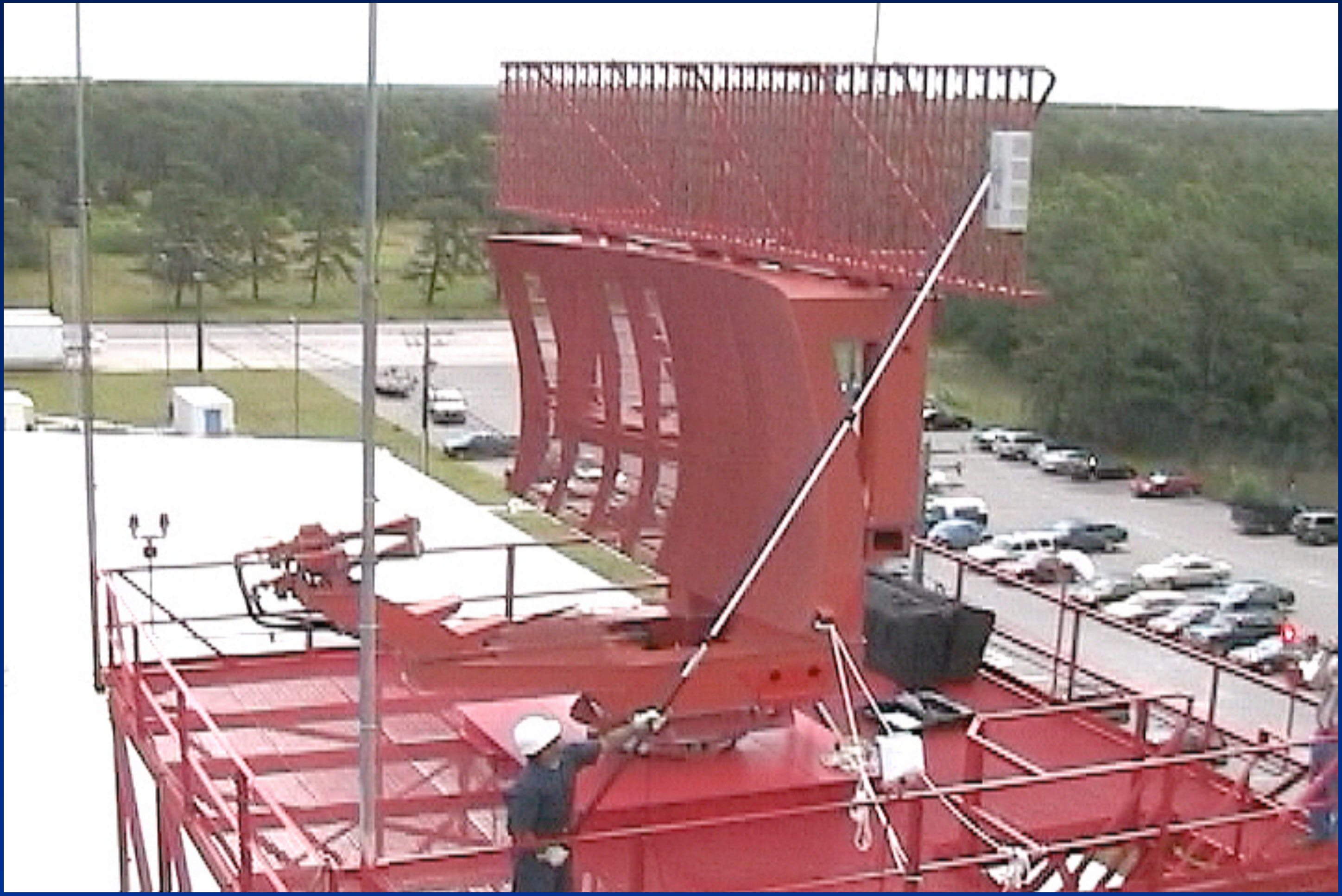


# Hazard Elimination Systems

## LED Lights (Low Maintenance)

# Hazard Elimination Systems

## Telescoping equipment



# Hazard Elimination Systems

## Antenna Relocation

# Fall Prevention Systems

# Stop a fall

- Always use a primary and a secondary system
  - Primary support is physically supporting your weight
  - Secondary system is not being used, but will support you if the primary fails
  - Don't connect primary and secondary system to the same anchor

# Secondary Systems

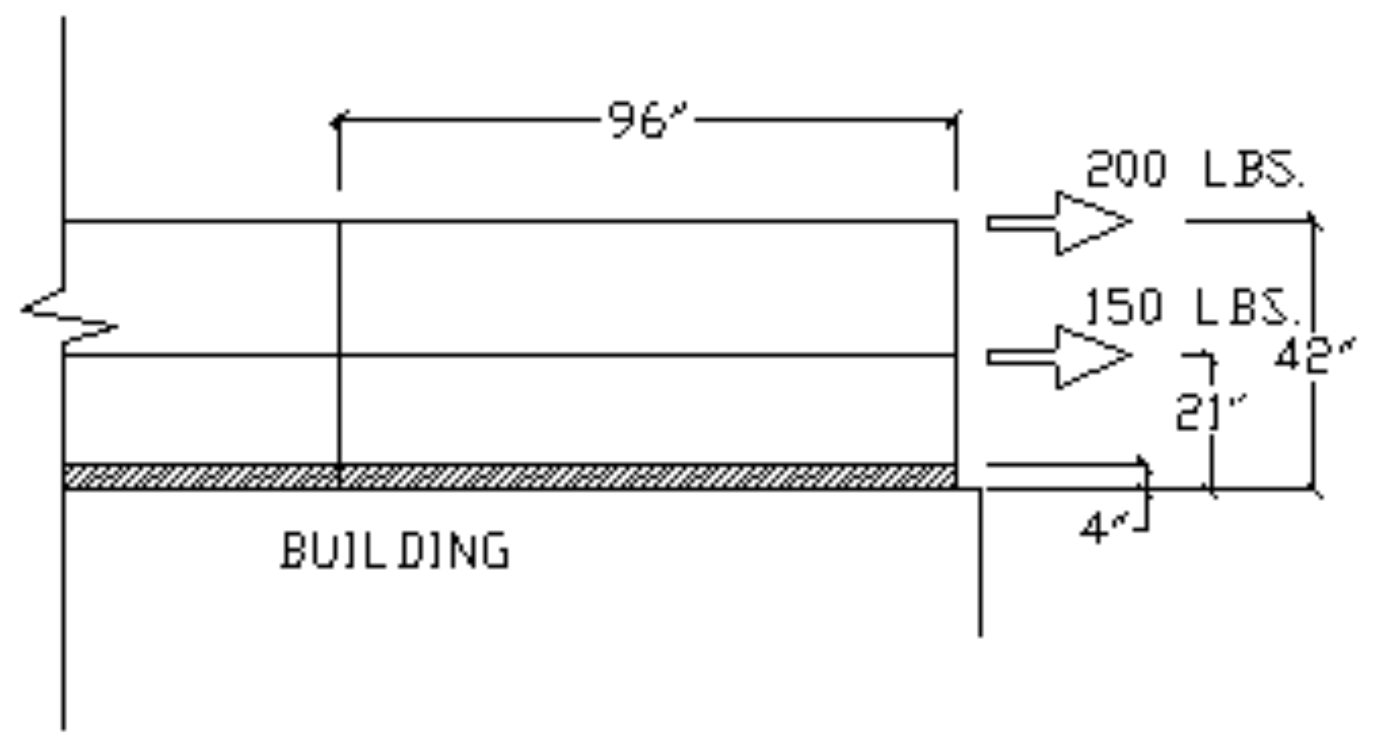
- Barrier Systems
- Fall Restraint Systems
- Warning Systems
- Fall Arrest Systems

# Barrier Systems

Guardrails

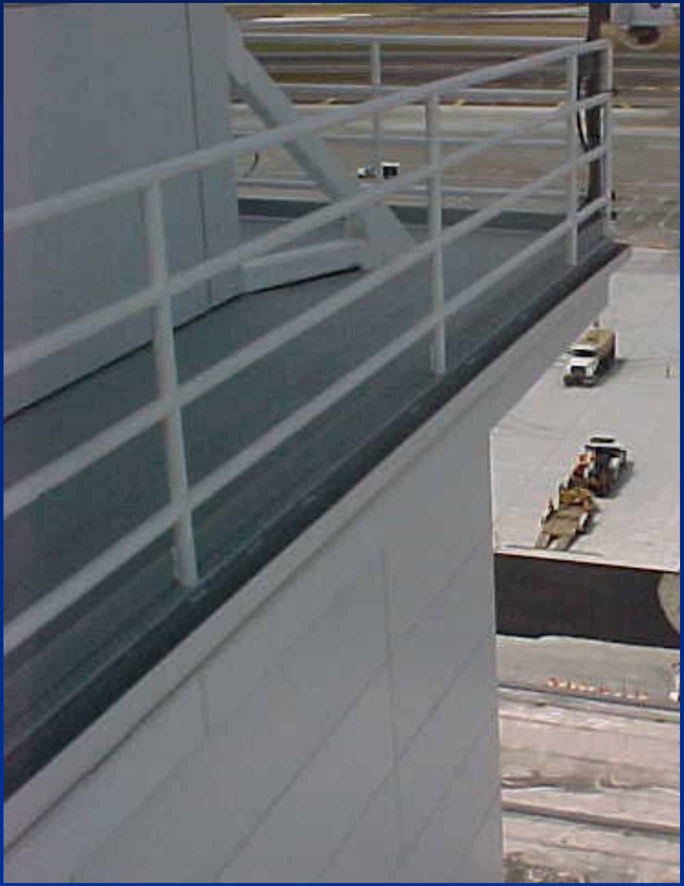
Hatches

# Guardrail Requirements

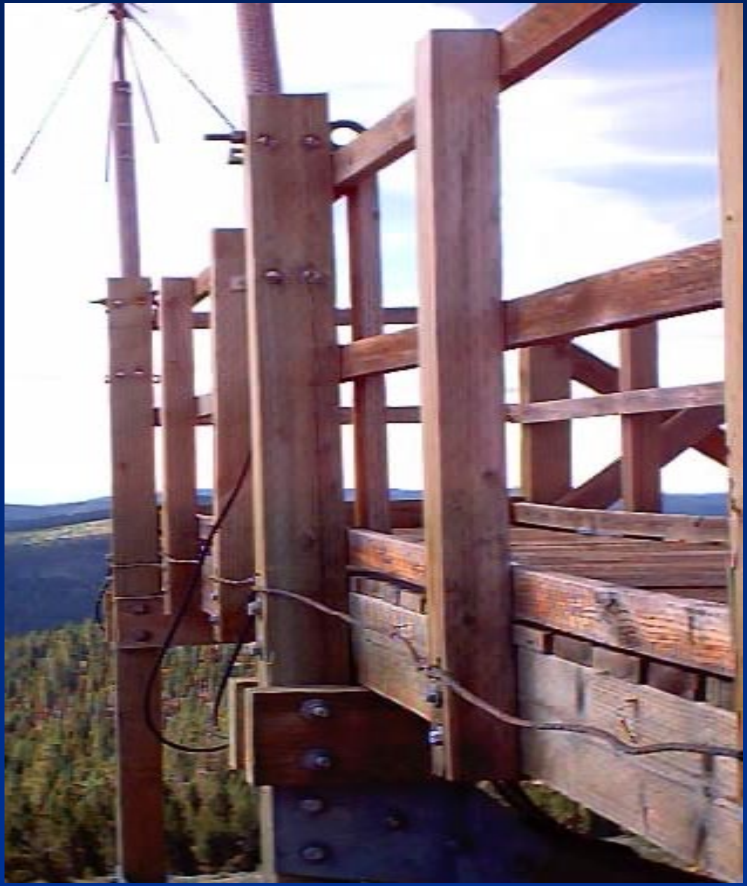


# Fall Prevention Systems
## Permanent Guardrails

Metal



Non-metal

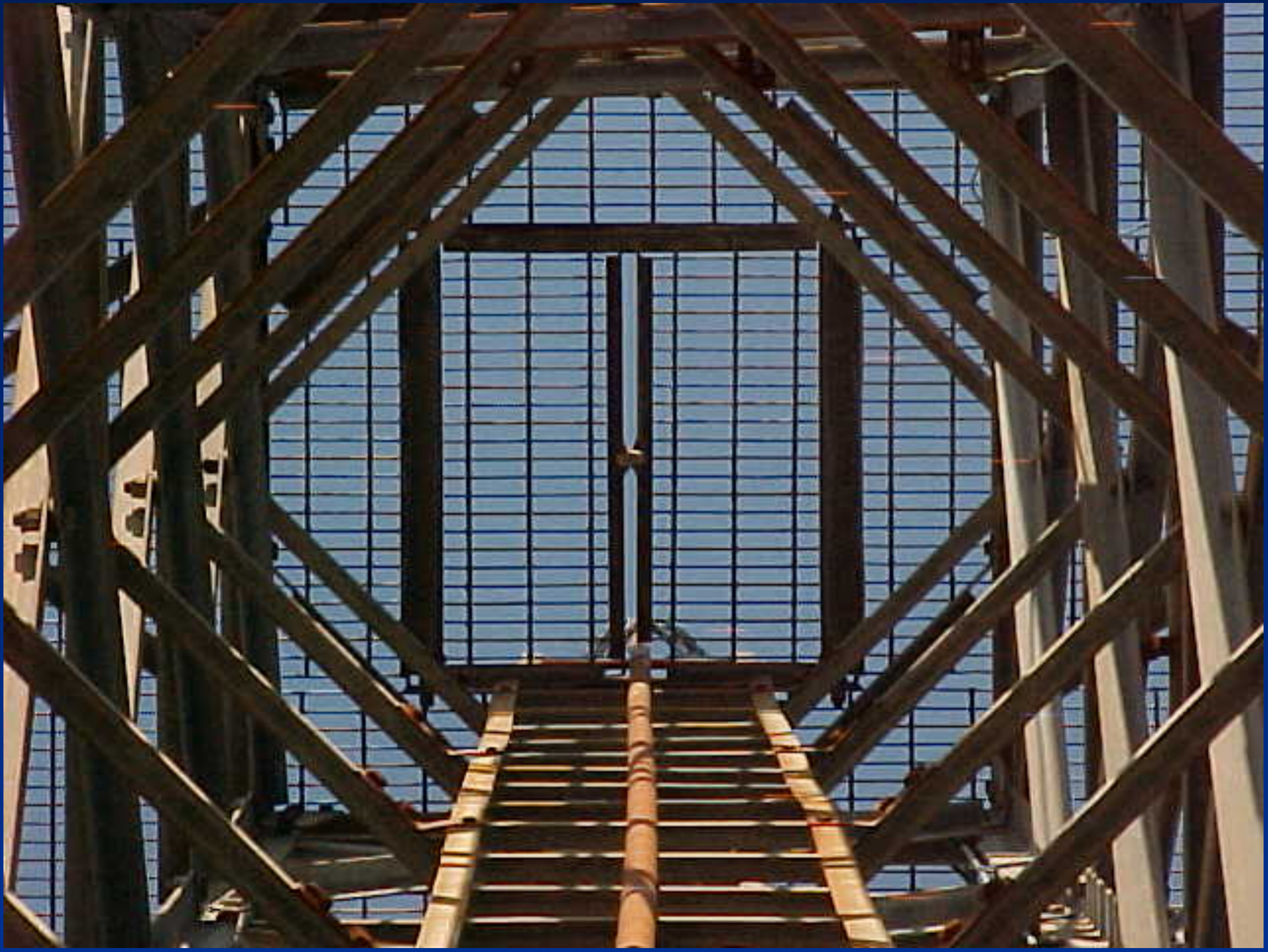


# Fall Prevention Systems

## Temporary Guardrails

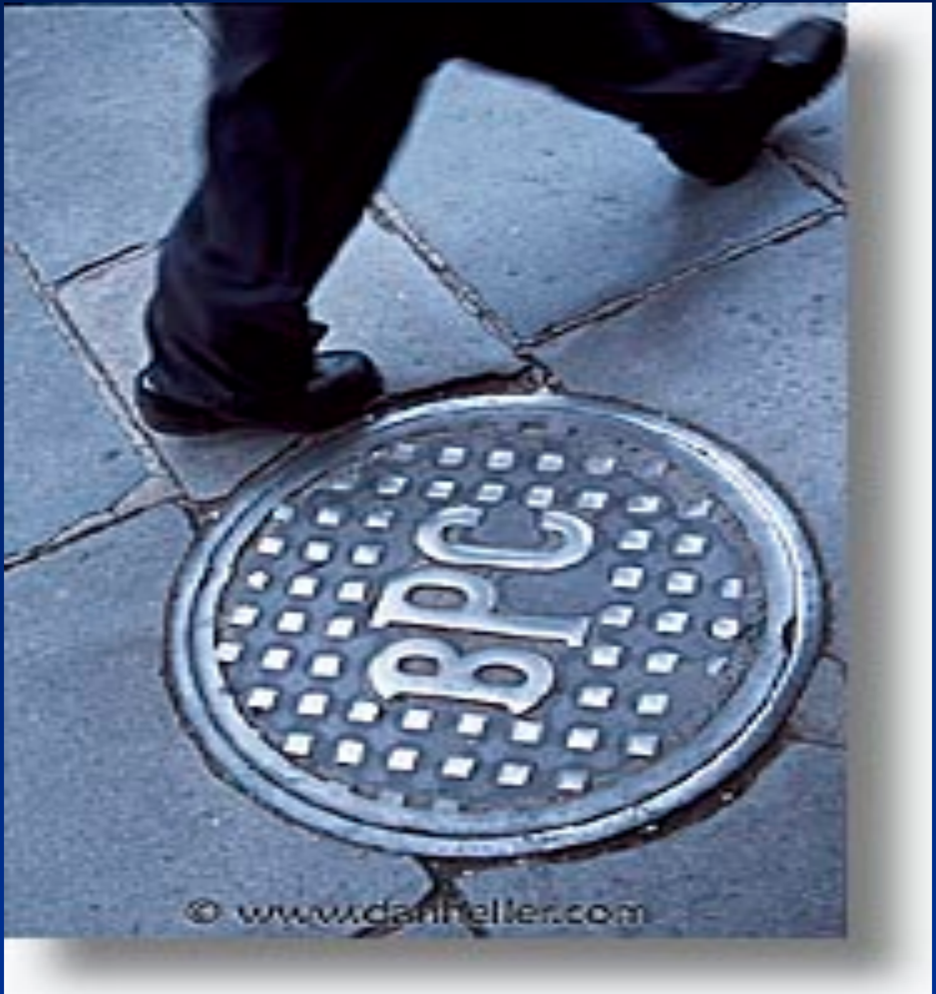
# Fall Prevention Systems

## Hatches



# Fall Prevention Systems

## Covers



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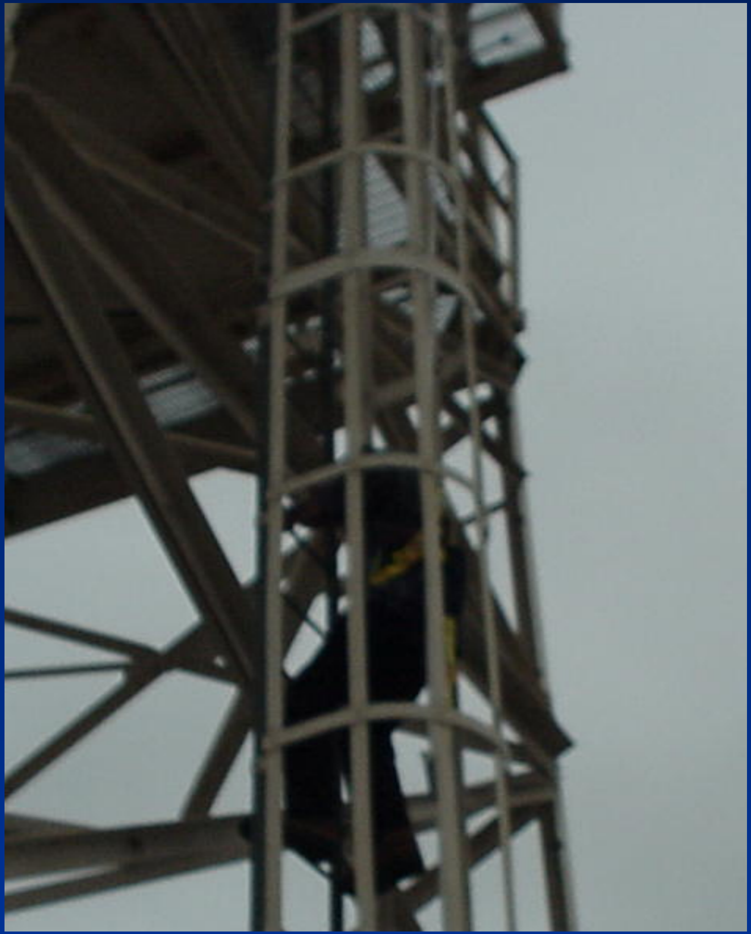
# Fall Prevention Systems

## Ladder Cages



# Fall Prevention Systems

## Lifts

- Personnel Lifts
  - Scissor Lifts
  - Articulating Lifts
- Advantages and Disadvantages?

Should we tie-off inside a personnel lift?

**!Yes – for restraint only!**

# Fall Prevention Systems

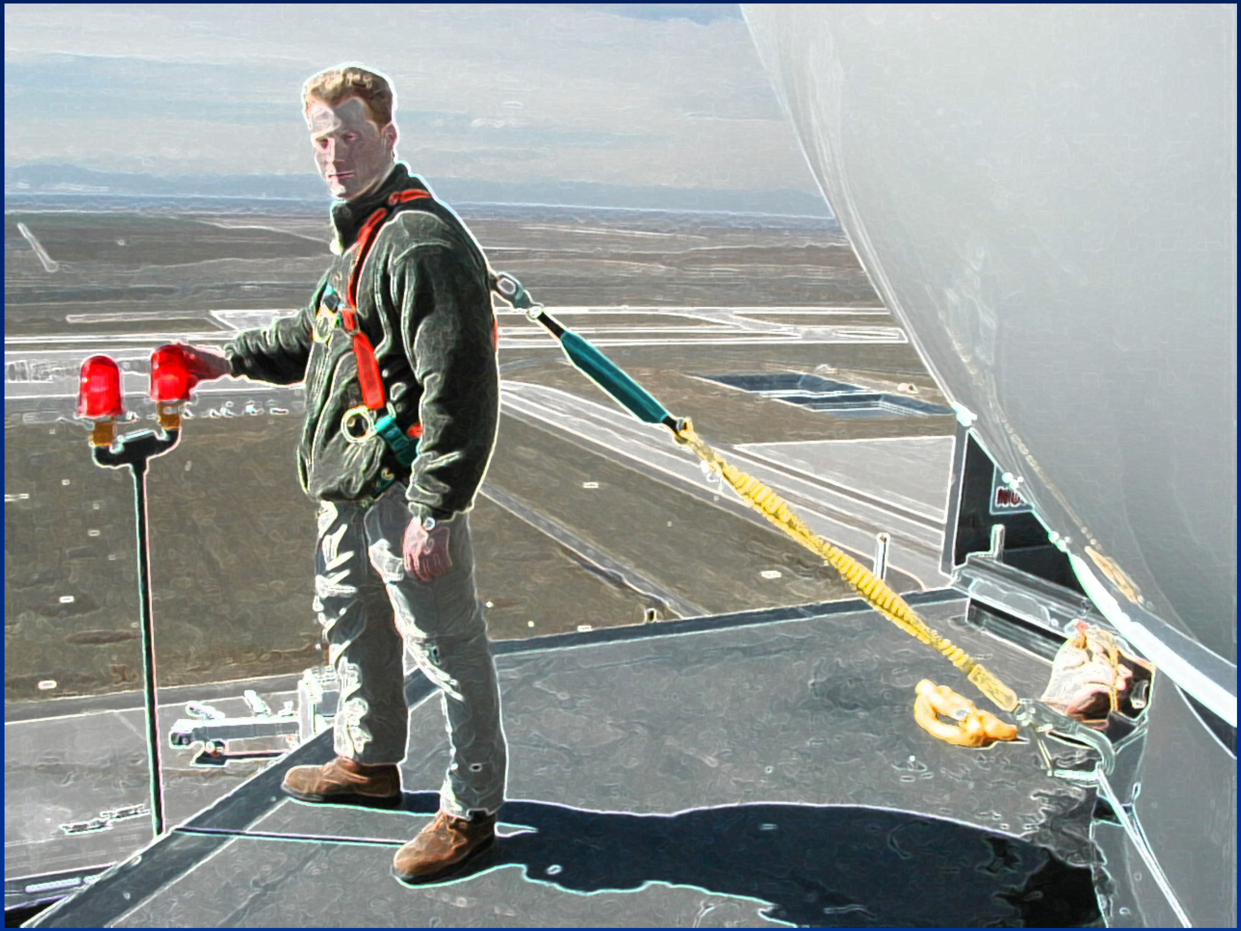
## Requirements for lifts:

- Only trained personnel shall operate an aerial lift
- Tying off or anchoring to an adjacent pole, structure, or equipment while working from the lift is ***not*** permitted
- Anchorage points shall be installed (by the manufacturer) inside the basket
- Individual shall always stand firmly on the floor of the basket
- Individuals shall not sit on, or climb on the edge of the basket, or use planks, ladders, or other devices for work position
- Full body harness will be worn and the lanyard attached to the anchorage point in the lift (articulating lifts) or the railing (only for restraint) in a scissor lift
- Lift shall not be moved when the boom is elevated and individuals are in the basket – except when the equipment is designed for this
- Entrance gate shall be hinged to open inwardly only

# Fall Prevention Systems

## Fall Restraint

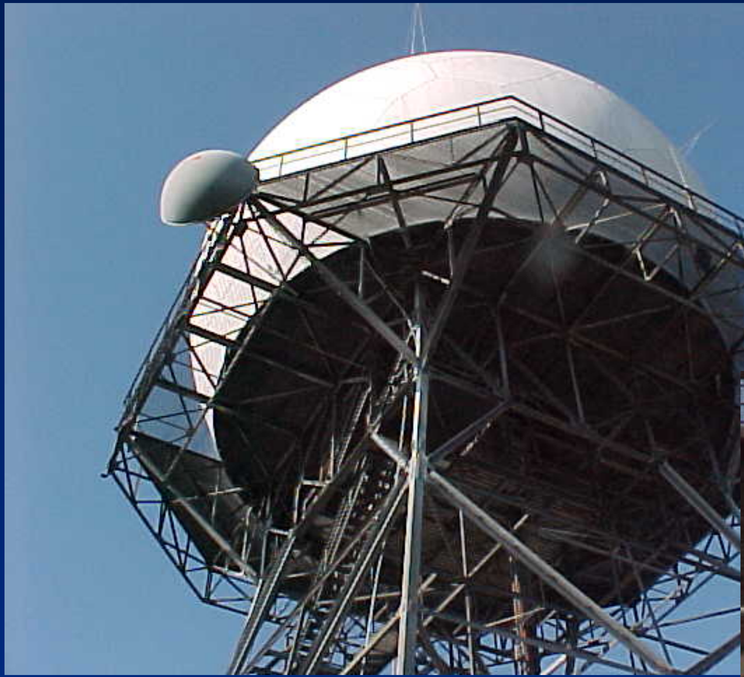
- Restrains climber from fall hazard

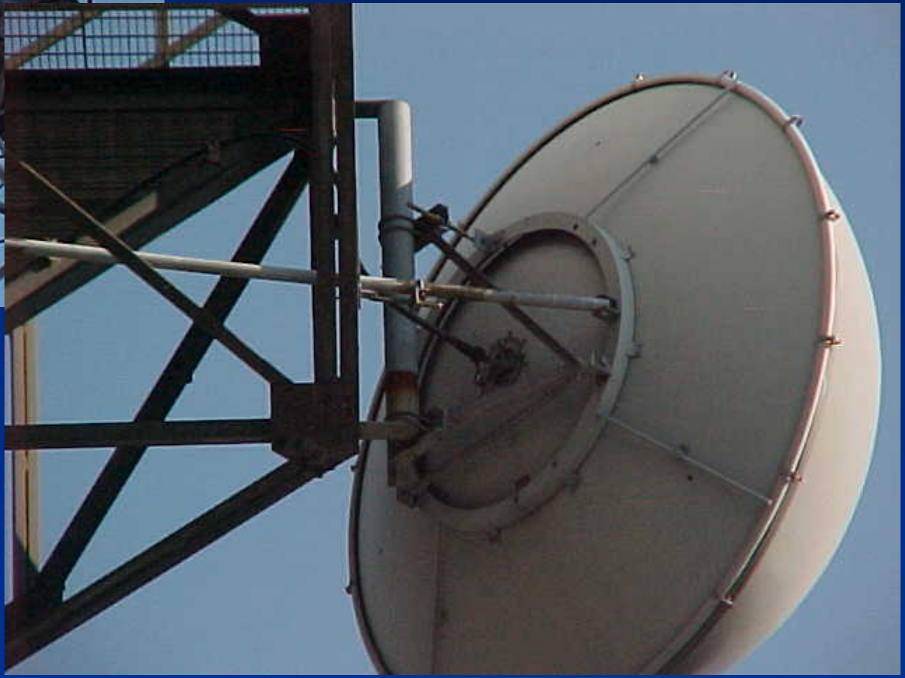


# Fall Prevention Exercise

- Propose hazard elimination/fall prevention solutions to your work situations
- List the positive characteristics and negative characteristics for your solutions
- Share with total group using a 1-pt lesson format
- 30 minutes for this exercise

# Fall Hazards - Example 1

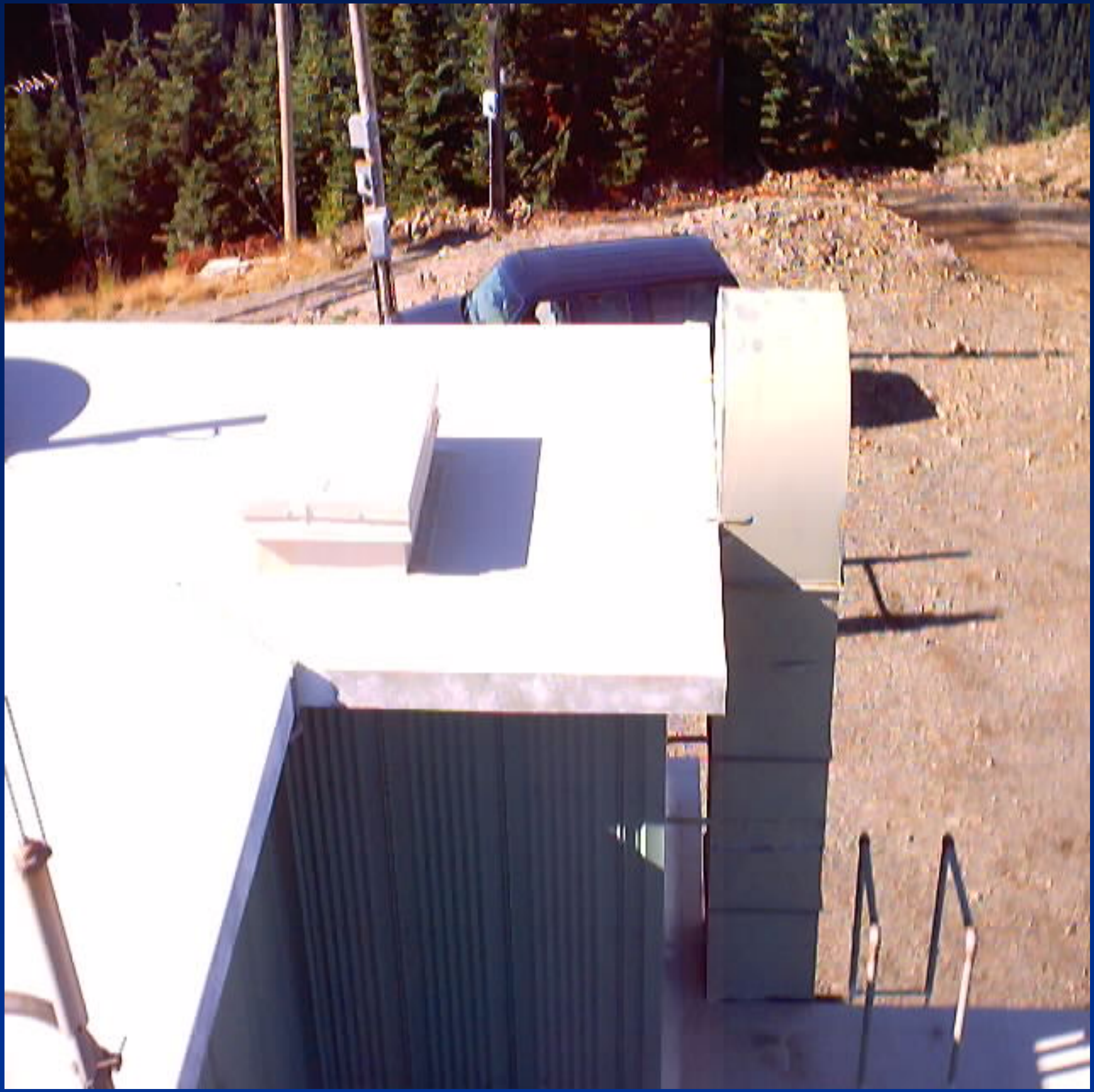




How to access the MCW dish?

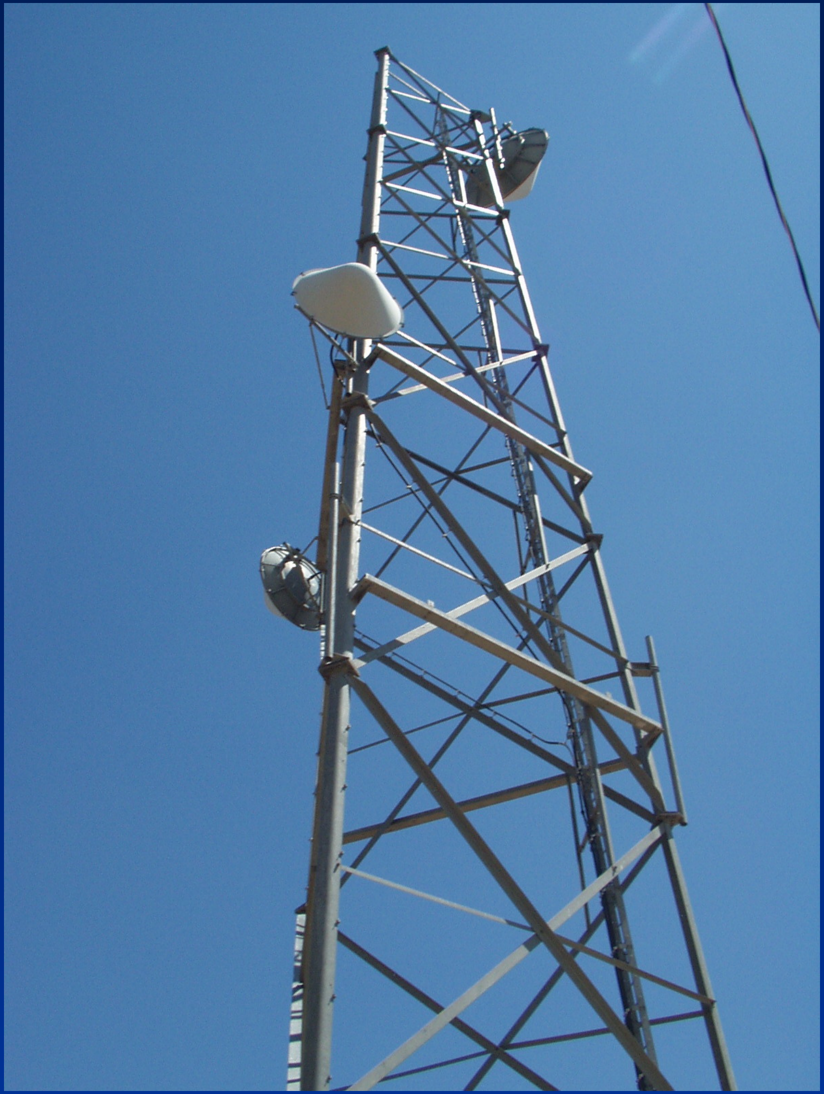
# Fall Hazards - Example 2

- Exit hatch, immediately unsafe. Note antenna in bottom left, on edge of roof



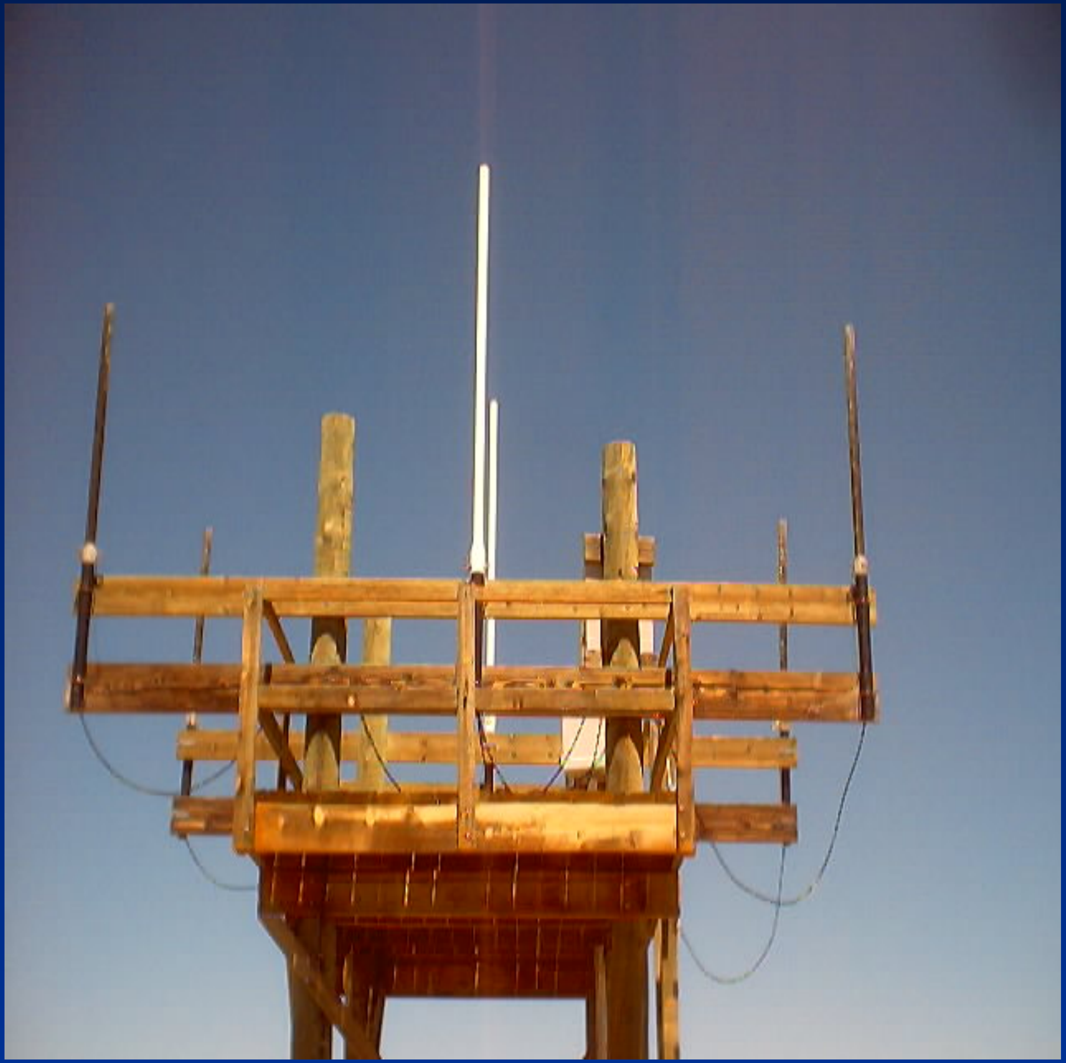
# Fall Hazards - Example 3

How to access back M/W



# Fall Hazards - Example 4

How to access antennas on stand-offs

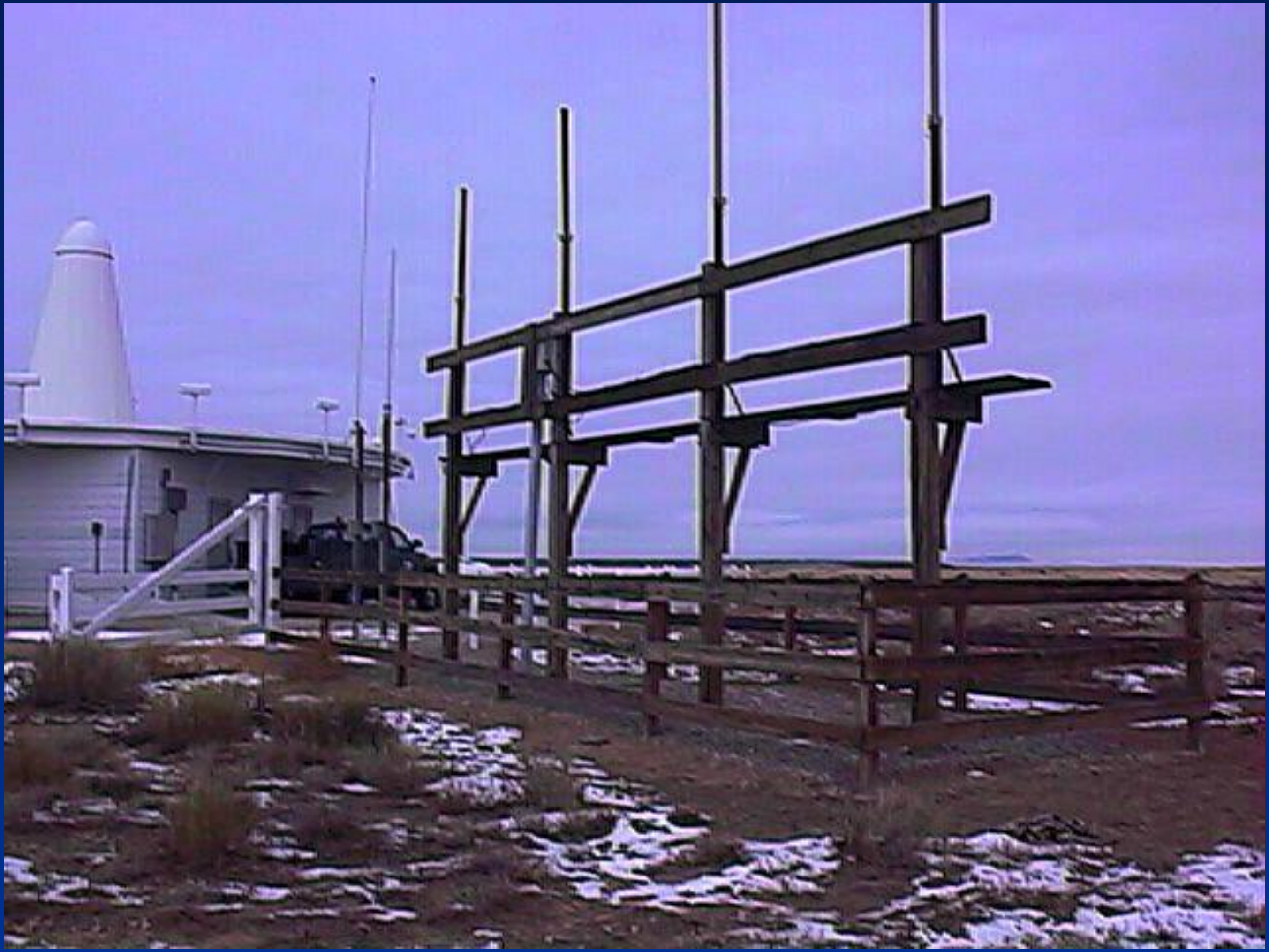


# Fall Hazards - Example 5

Nothing on tower can support 5000 lb

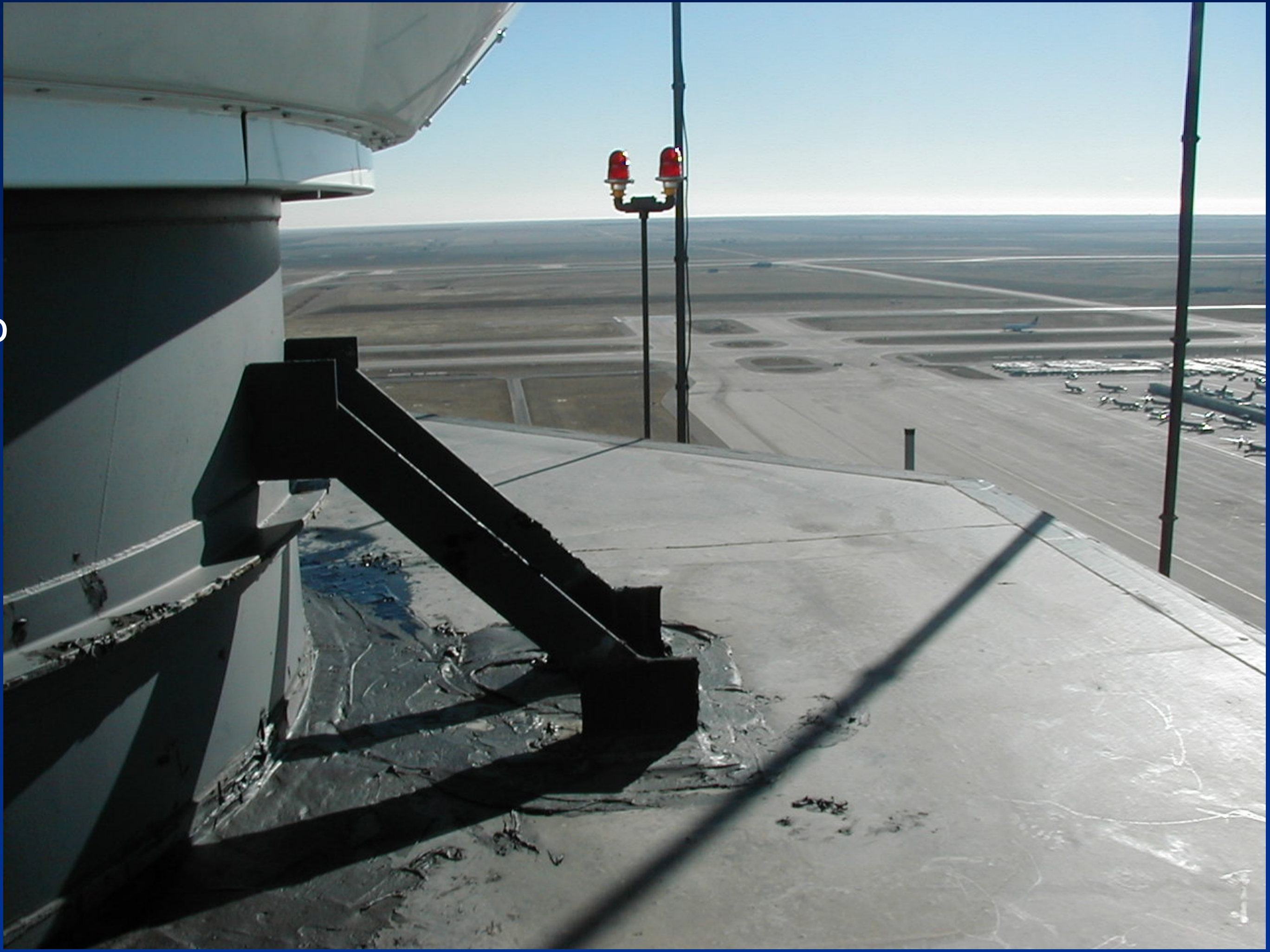
# Fall Hazards - Example 6

No guardrails or access to antenna platform

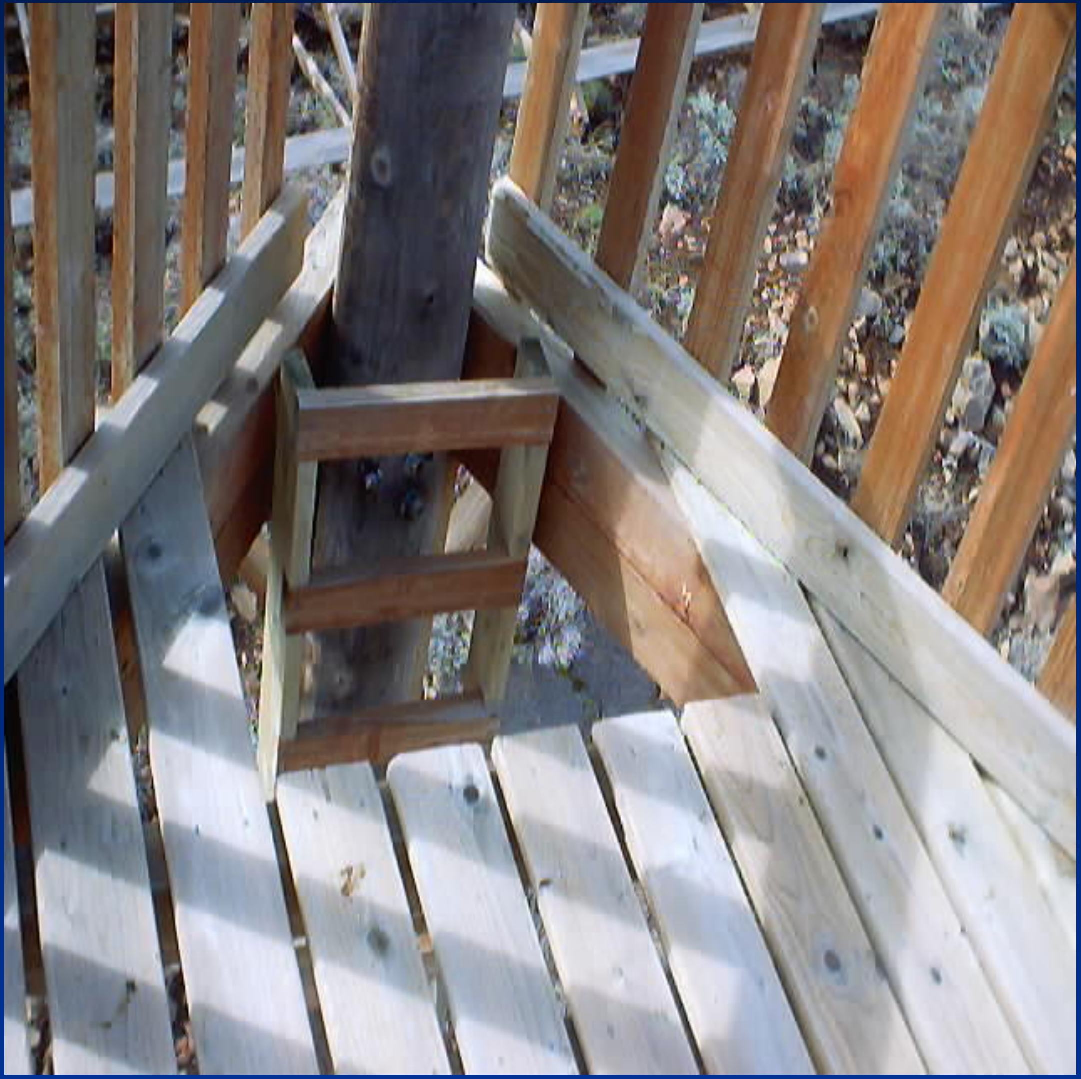


# Fall Hazards - Example 7

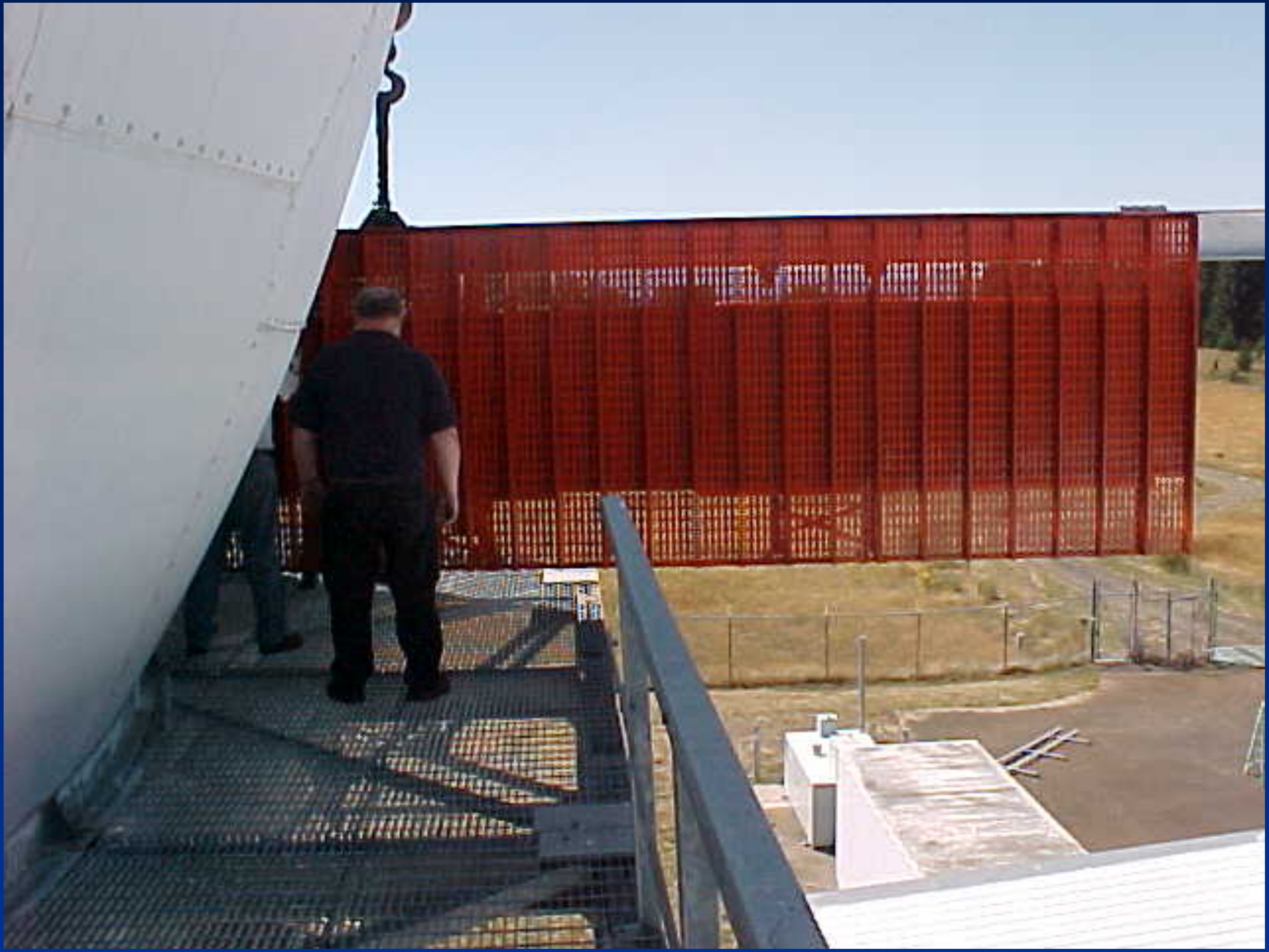
Exposed roof edge, need to access OB lights & antennas



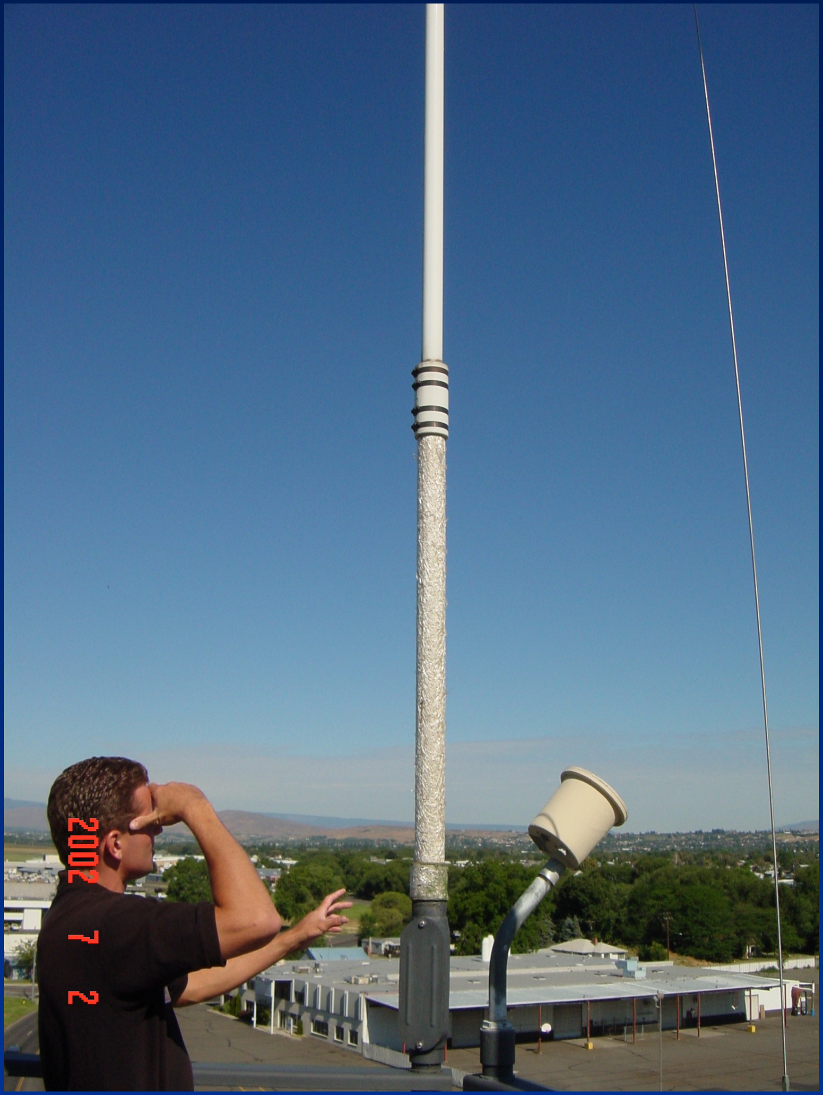
# Fall Hazards - Example 8



# Fall Hazards - Example 9

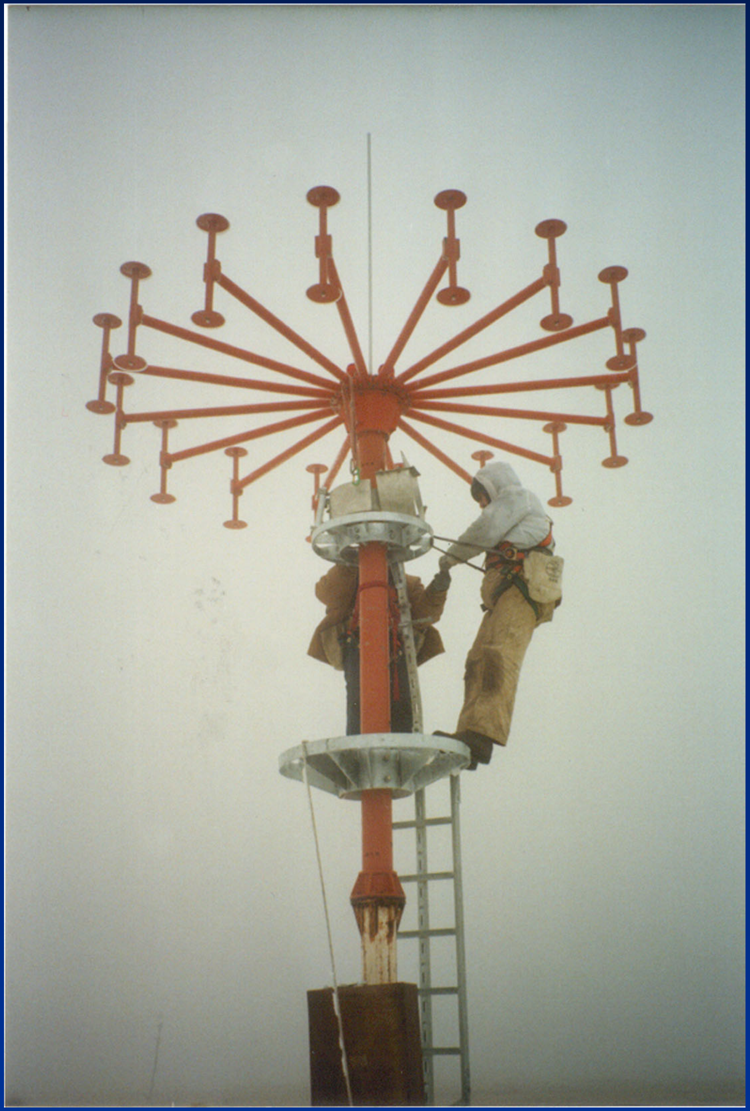


# Fall Hazards - Example 10

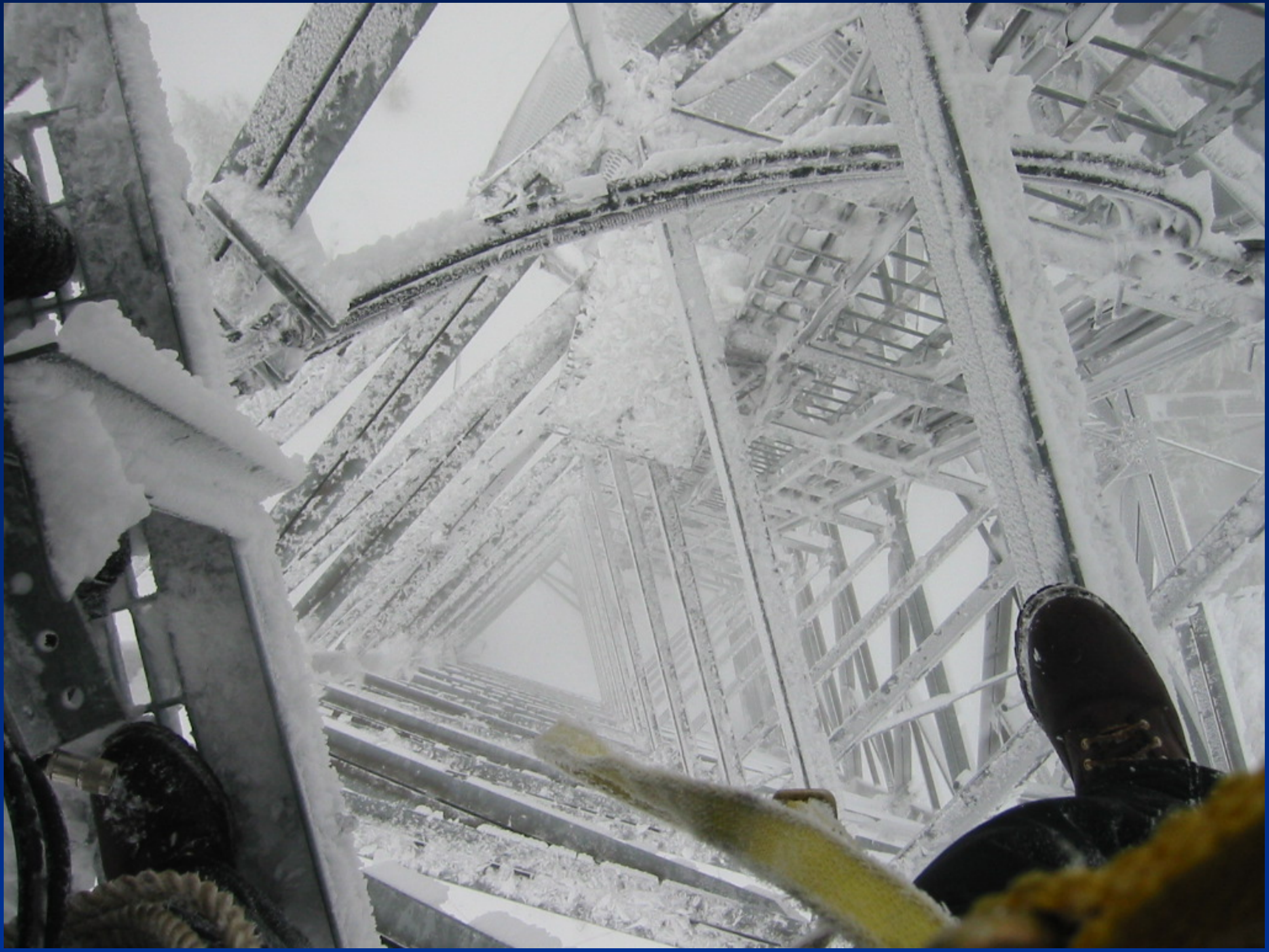


# Fall Hazards - Example 11

# Fall Hazards - Example 12



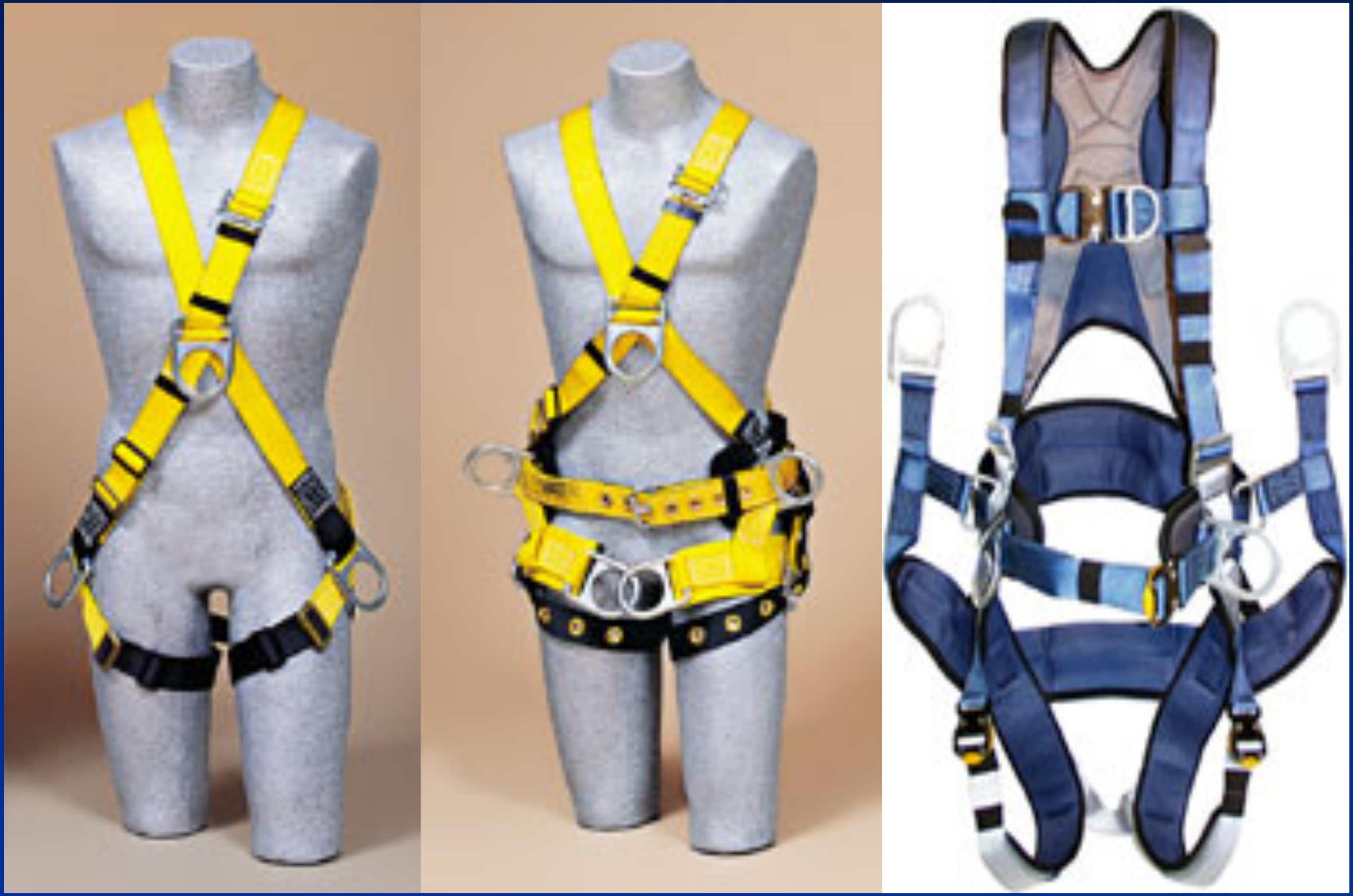
# Fall Hazards – Example 13



- Personal Fall Arrest Systems
- Administrative (Warning) Techniques

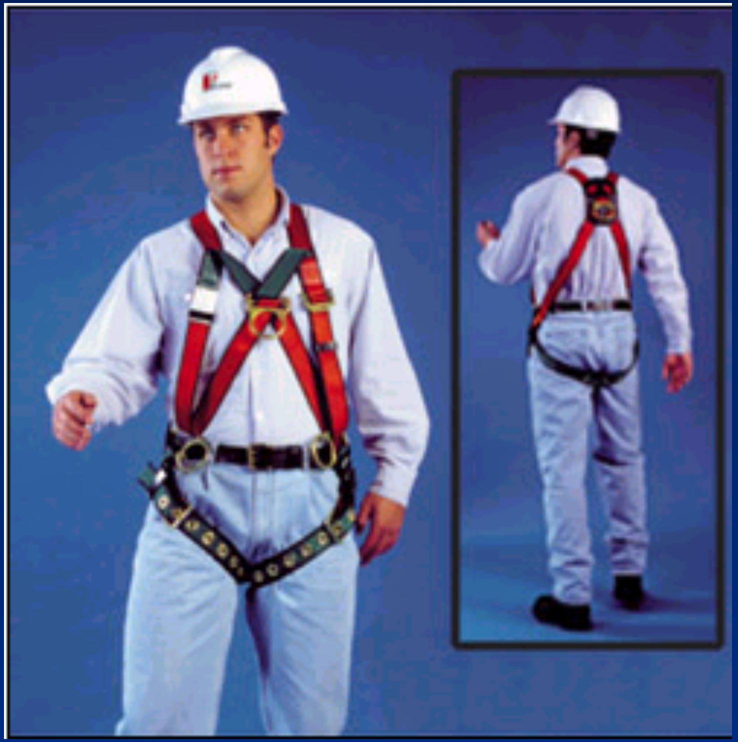
# Personal Fall Arrest Systems (PFAS)

# PFAS - Harnesses



# PFAS - Full Body Harness

- Full Body Harness
  - Leg closures
  - No metal above the waist for electrical work
  - Back D-ring for fall arrest
  - Front D-ring for rescue
  - Side D’s for positioning
  - Kevlar for hot work/ welding
- What about Body Belts?



# PFAS - Body Belts

# Attachment Points

MSA Drop Test Video

# Safe Work Practices

# Personal Protective Equipment (PPE)

- Required for tower work
  - Fall Arrest Equipment
  - Hard Hat
- Recommended for tower work
  - Gloves
  - Work Positioning Device
  - Tool Bag
  - Steel shanked boots

# Work Positioning Device

- Various styles
- Use for hands-free work
- Not a substitute for fall arrest

# Tool Bag

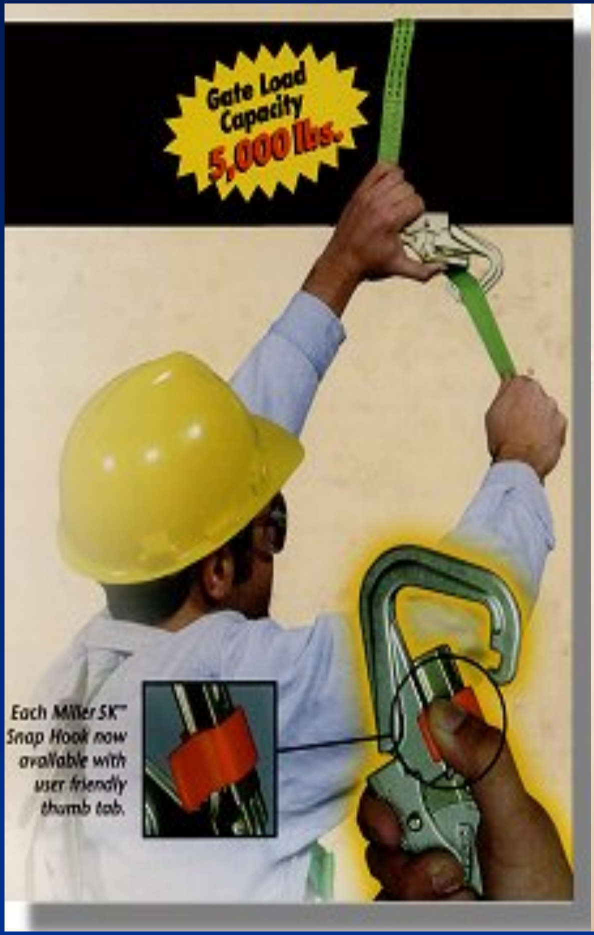
- Enough capacity to keep hands free for climbing

# Boots

# Snaphook Connections

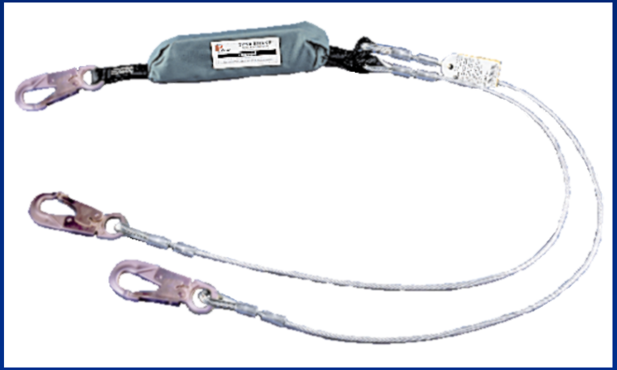
- All snap hooks and carabiners must be self-closing and self-locking
- All snap hook/D-ring combinations must be compatible - check for possibility of roll out

# PFAS - Shock Absorbing Lanyards

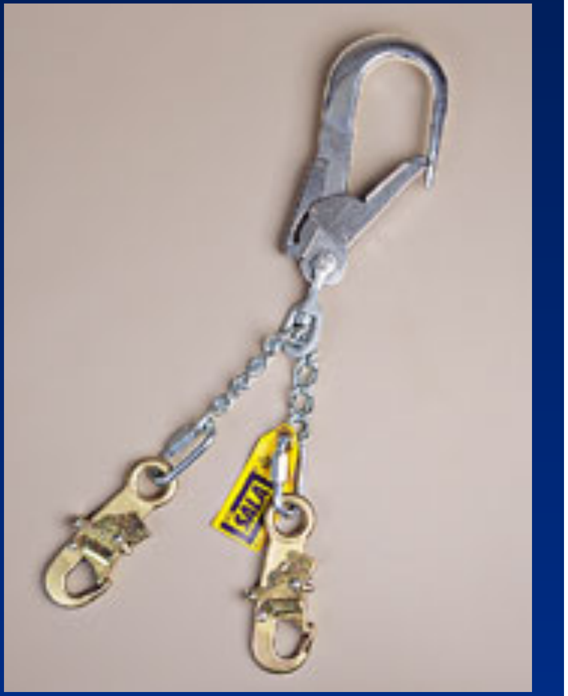

Gate Load Capacity 5,000 lbs.
Each Miller SK™ Snap Hook now available with user friendly thumb tab.

# PFAS - Shock Absorbing Lanyard

- Shock Absorbing Lanyard
  - Energy absorber shock pack
  - Double locking snap hooks, or locking carabiner
  - Minimal length for the work – no longer than 1.8 m (6 feet)



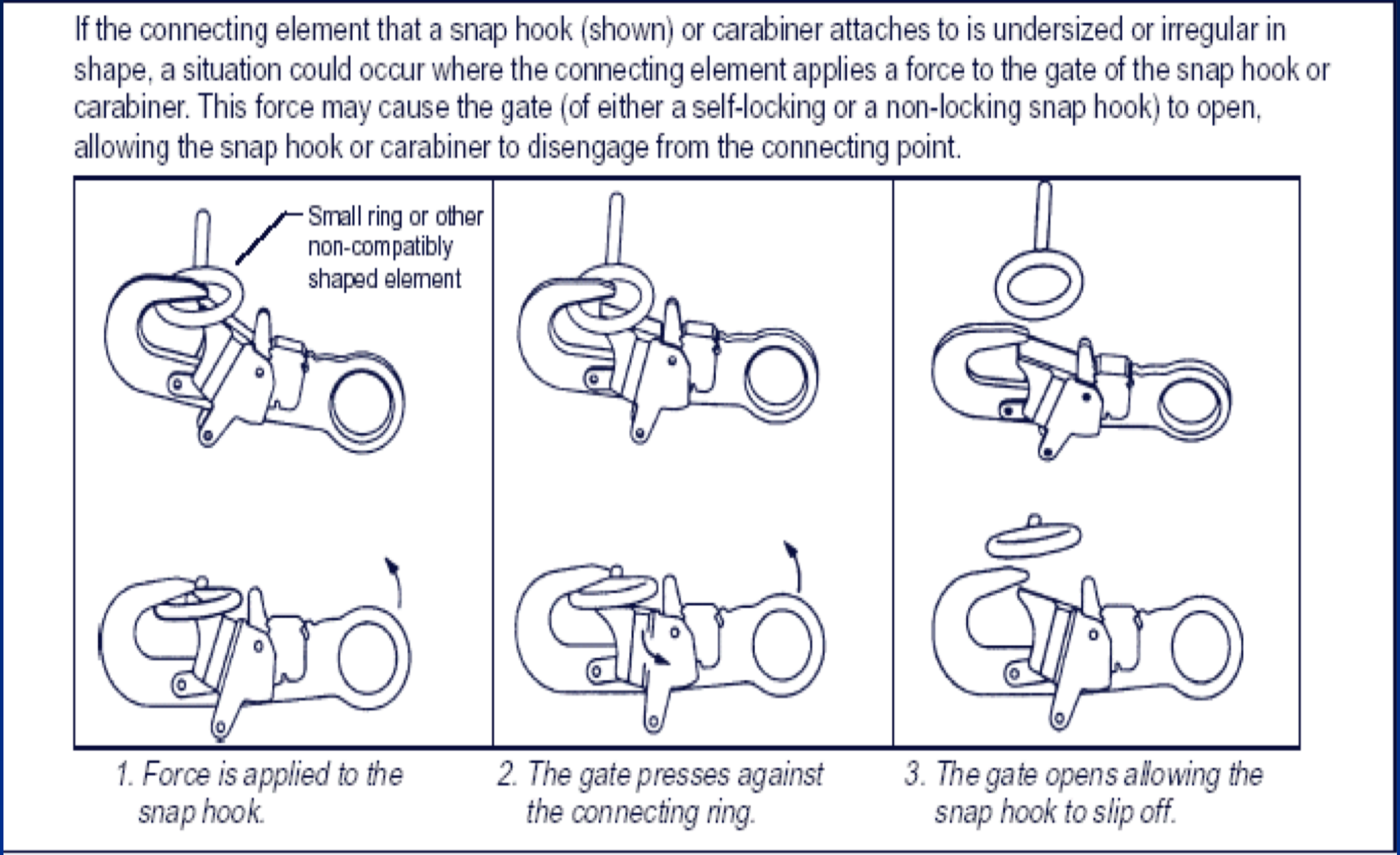
# PFAS - Work Positioning Systems



# PFAS - Connectors

- All snap hooks and carabiners must be self-closing and self-locking
- All snap hook/D-ring combinations must be compatible - check for possibility of roll-out

# Roll Out



If the connecting element that a snap hook (shown) or carabiner attaches to is undersized or irregular in shape, a situation could occur where the connecting element applies a force to the gate of the snap hook or carabiner. This force may cause the gate (of either a self-locking or a non-locking snap hook) to open, allowing the snap hook or carabiner to disengage from the connecting point.

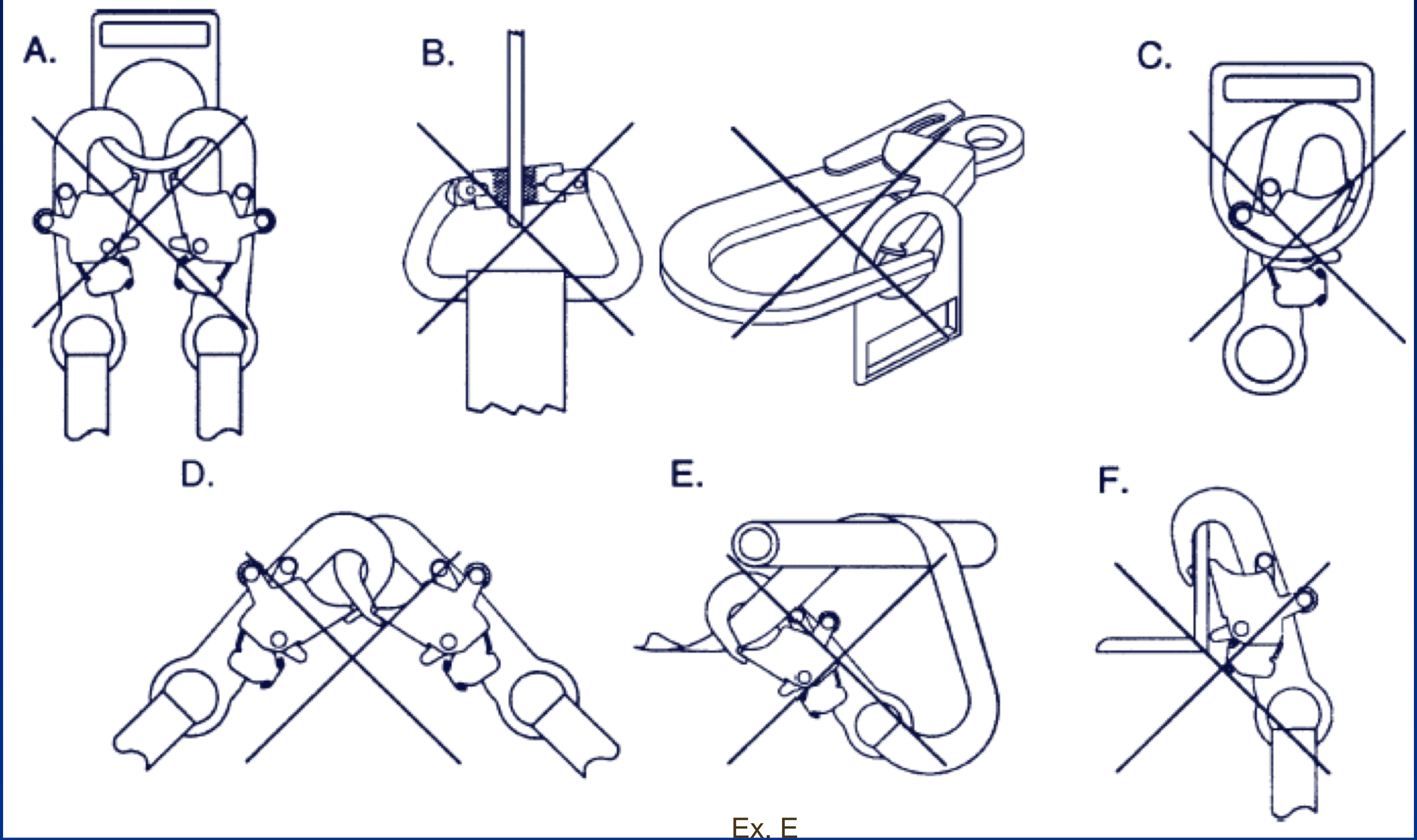
*1. Force is applied to the snap hook.*

*2. The gate presses against the connecting ring.*

*3. The gate opens allowing the snap hook to slip off.*

# Connecting Snaphooks

Ex. A
D-Ring
(5000 lbs)
is not
rated for
2 snap-
hooks
(5000 lbs
each)



Ex. E
Never wrap webbing
and secure with same
attached hook

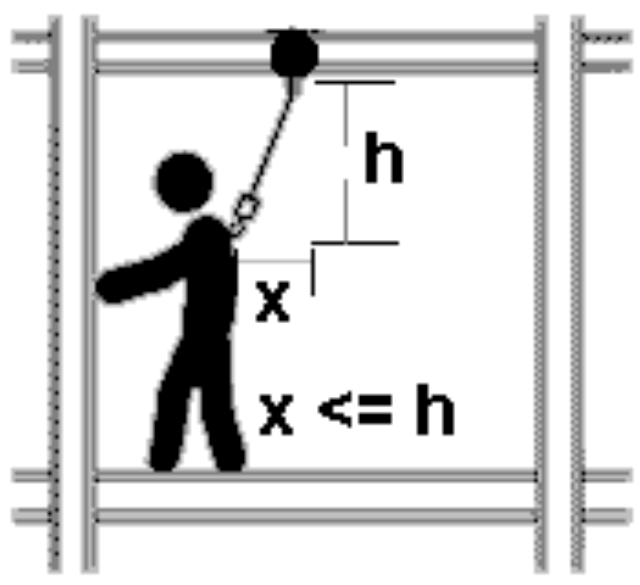
# PFAS - Ladder Climbing Devices

- Ladder Climbing Device
  - Used with Fixed Ladders
  - Used with a full body harness
  - Minimal length lanyard connected in front

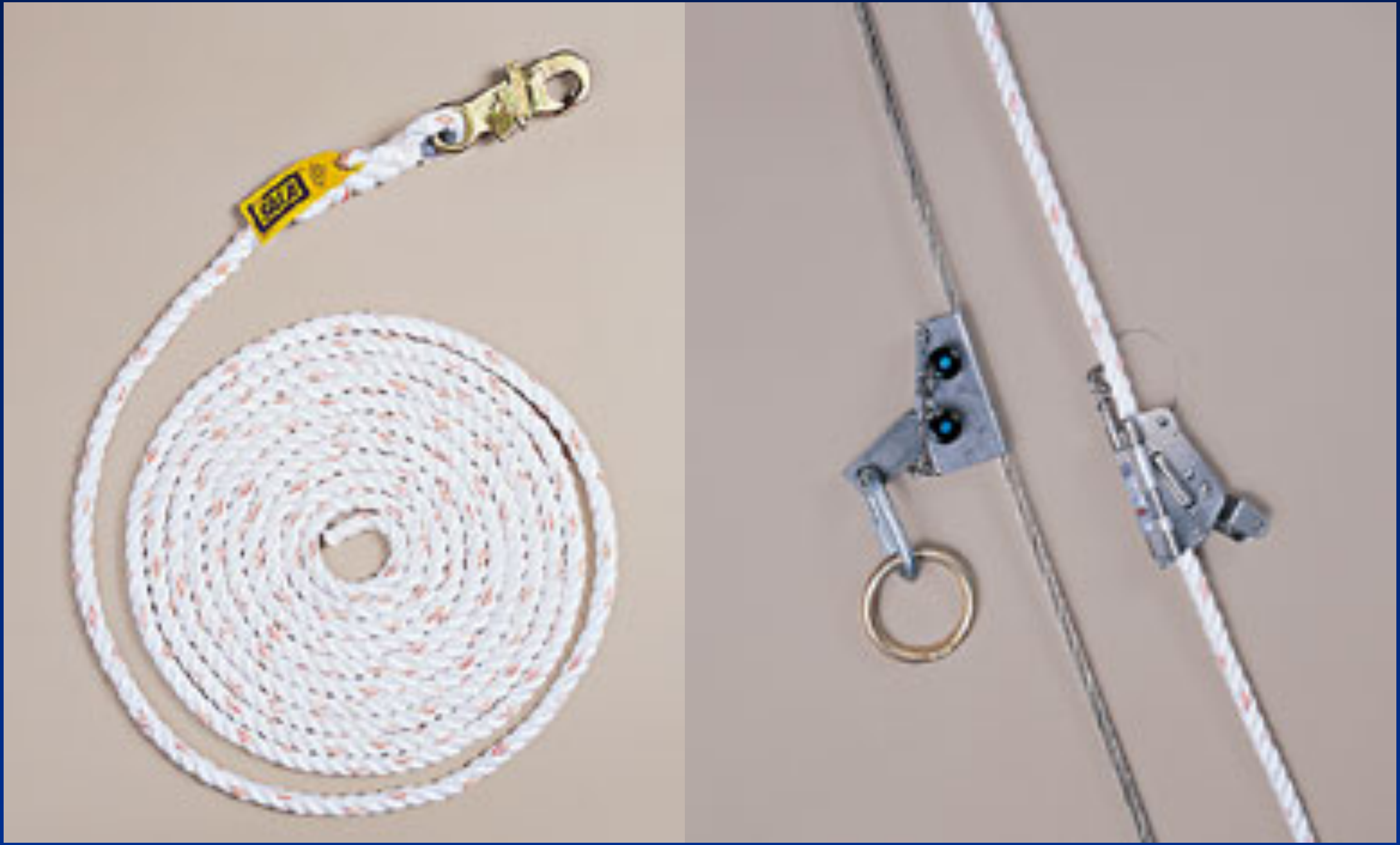
# PFAS - Self Retracting Lifelines

# PFAS - Self Retracting Lifelines

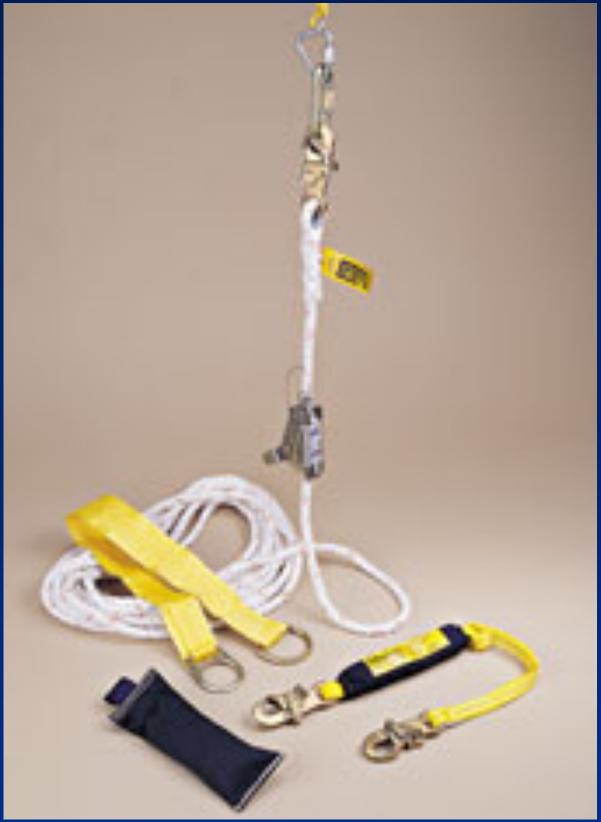
- Self-Retracting Lanyard
  - Double locking snap hooks
  - Minimizes free fall distance
  - Maintain overhead anchorage



# PFAS - Ropes & Rope Grabs



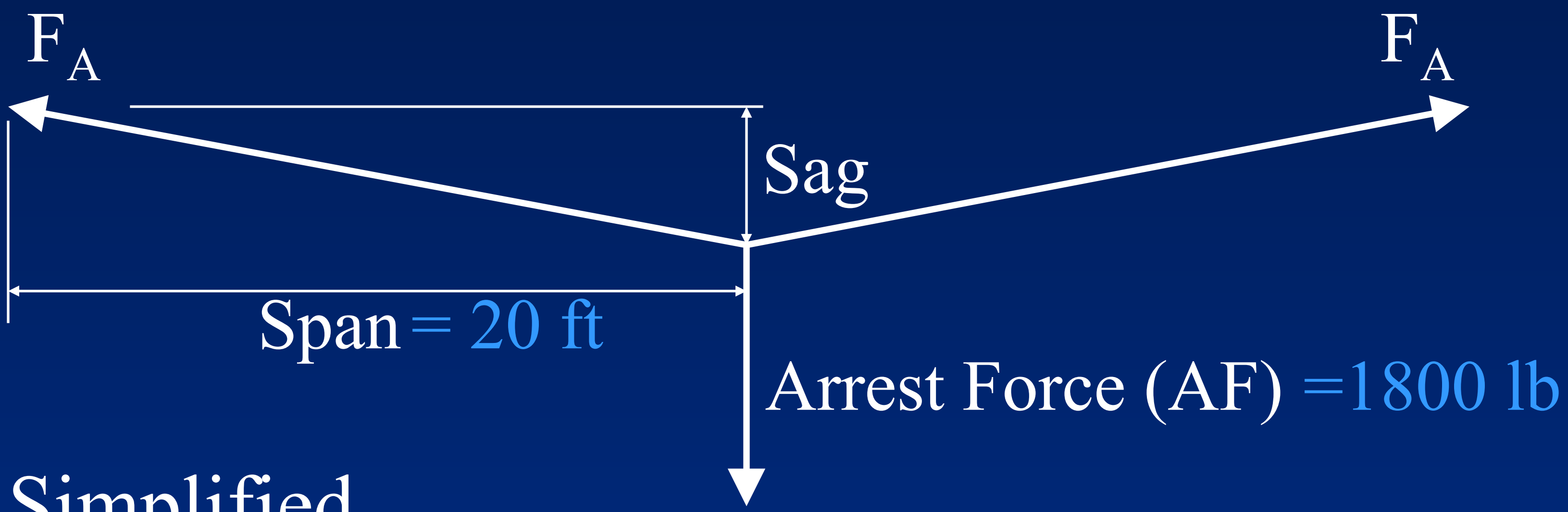
# PFAS - Vertical Lifelines



# PFAS - Horizontal Lifelines

- Must be designed by a qualified person
  - – end forces
  - – fall clearances

# Horizontal Lifeline Example



$F_A$

$F_A$

Sag

Span = 20 ft

Arrest Force (AF) =1800 lb

Simplified Calculation:

$$F_A = \frac{W \text{ x span}}{2 \text{ x sag}}$$

If $X = 3$ ft, $F_A = 6000$ lb

If $X = 2$ ft, $F_A = 9000$ lb

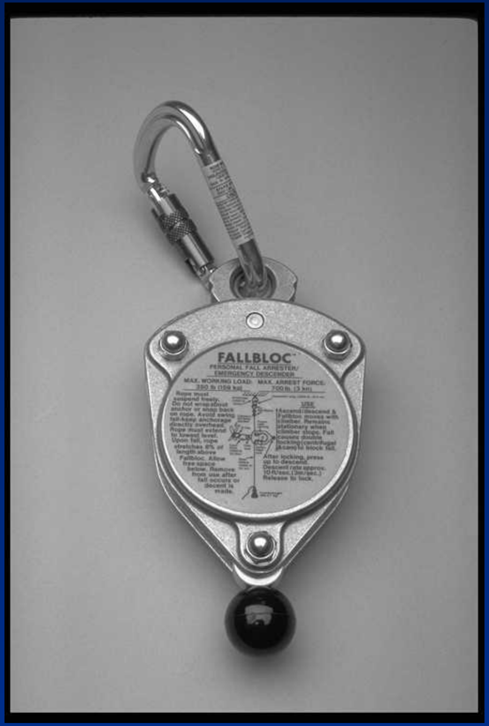
If $X = 1$ ft, $F_A = 18{,}000$ lb

# Horizontal Lifelines

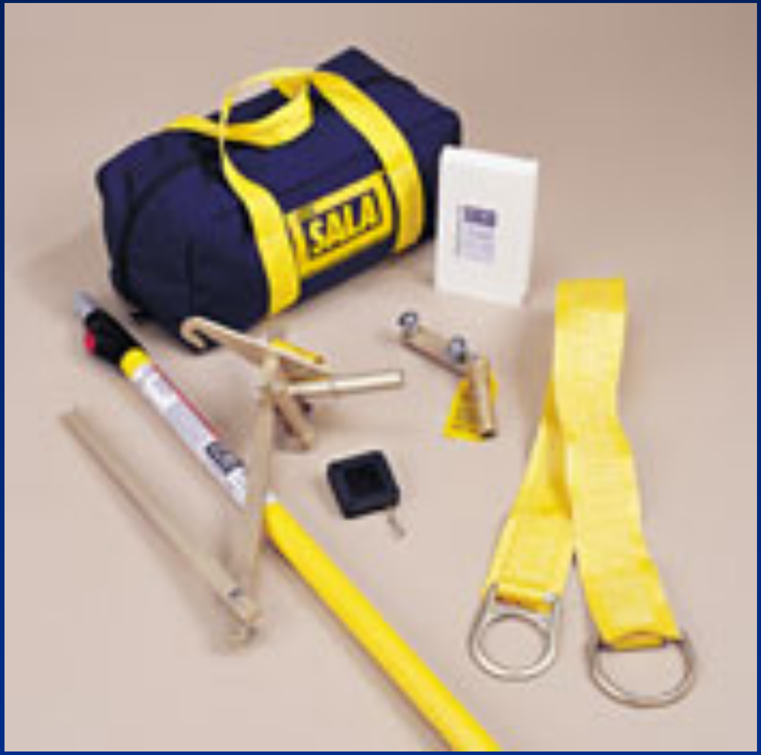
- Additional design considerations:
  - Lifeline stretch
  - HLL shock absorbers
  - Elastic and plastic deformation of anchors
  - Possible multiple falls
  - More complex calculations for fall clearances

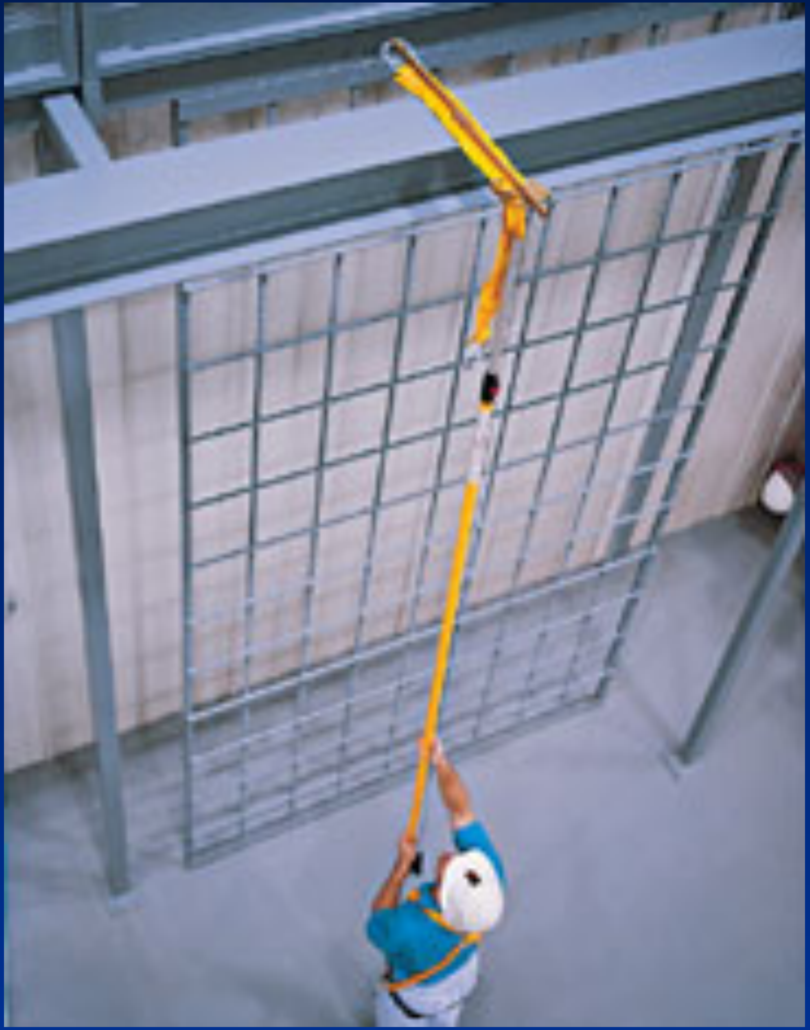
# PFAS - Automatic Descent Devices

- Controlled Descent Device
  - Sets a maximum rate of descent
  - No free fall



# PFAS - First Man Up Devices



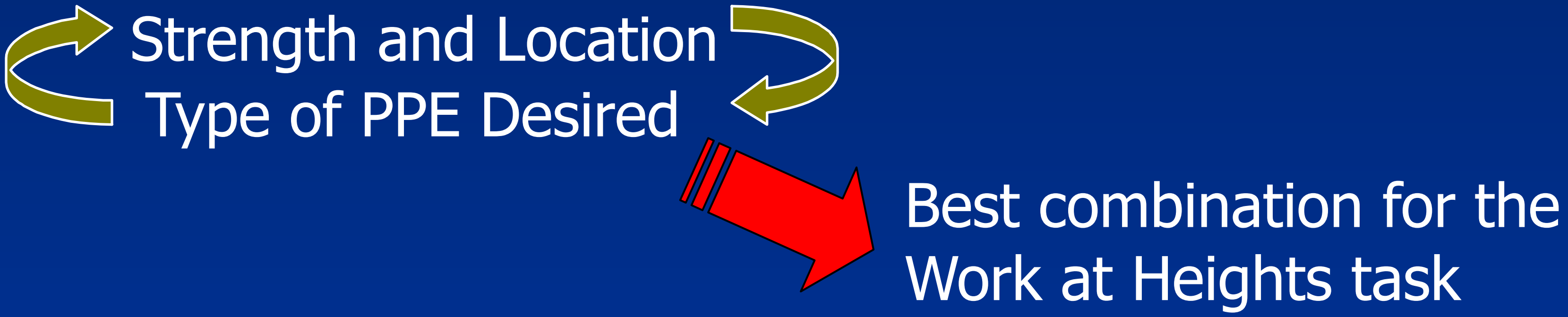


# PFAS - Nets

- Nets
  - Frequently used with both horizontal and vertical lifelines
  - Specify with debris containment
  - Construction applications

# PFAS - Selection Considerations

- What all do we consider before using PPE?
  - Free-Fall Distance
  - Required Fall Clearances
  - Maximum Arresting Force
  - Anchorage Point Strength and Location
  - Rescue Considerations



Strength and Location

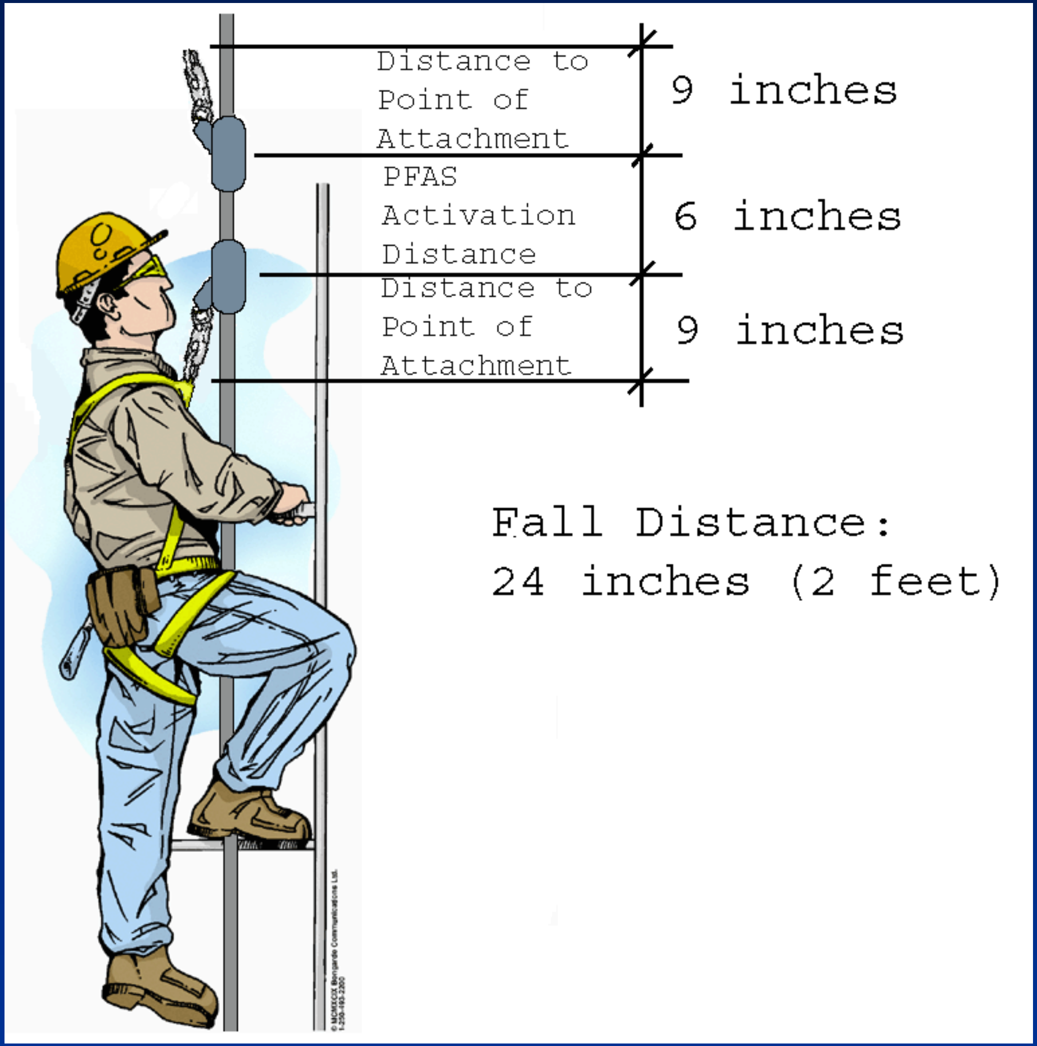
Type of PPE Desired

Best combination for the Work at Heights task

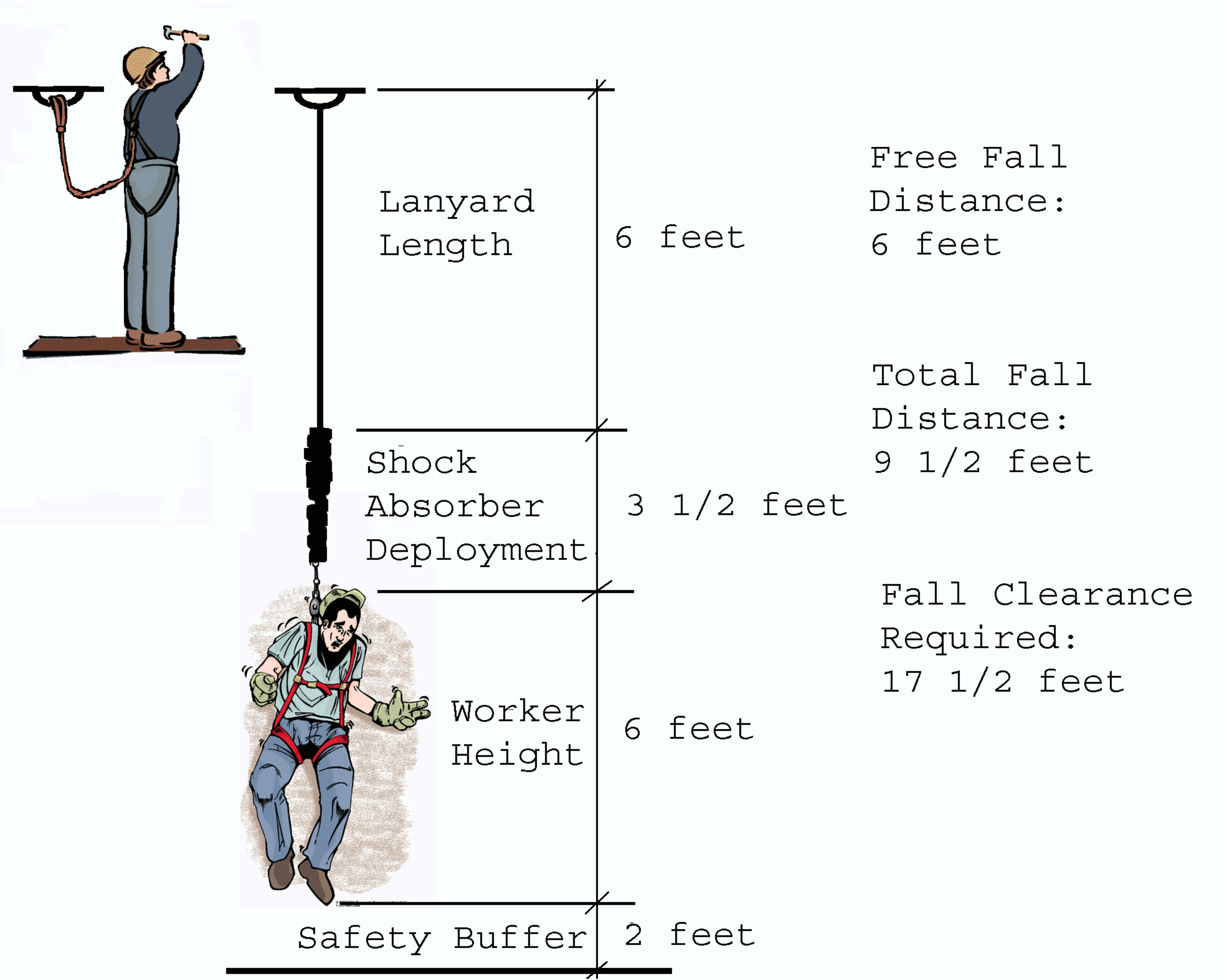
# Fall Clearance

- Fall Clearance is the distance required below the anchor point for an effective fall arrest system. It equals the sum of:
  - Free Fall distance
  - PFAS activation distance
  - Deceleration Distance
  - Stretch in the system
  - Height of worker
  - Safety buffer

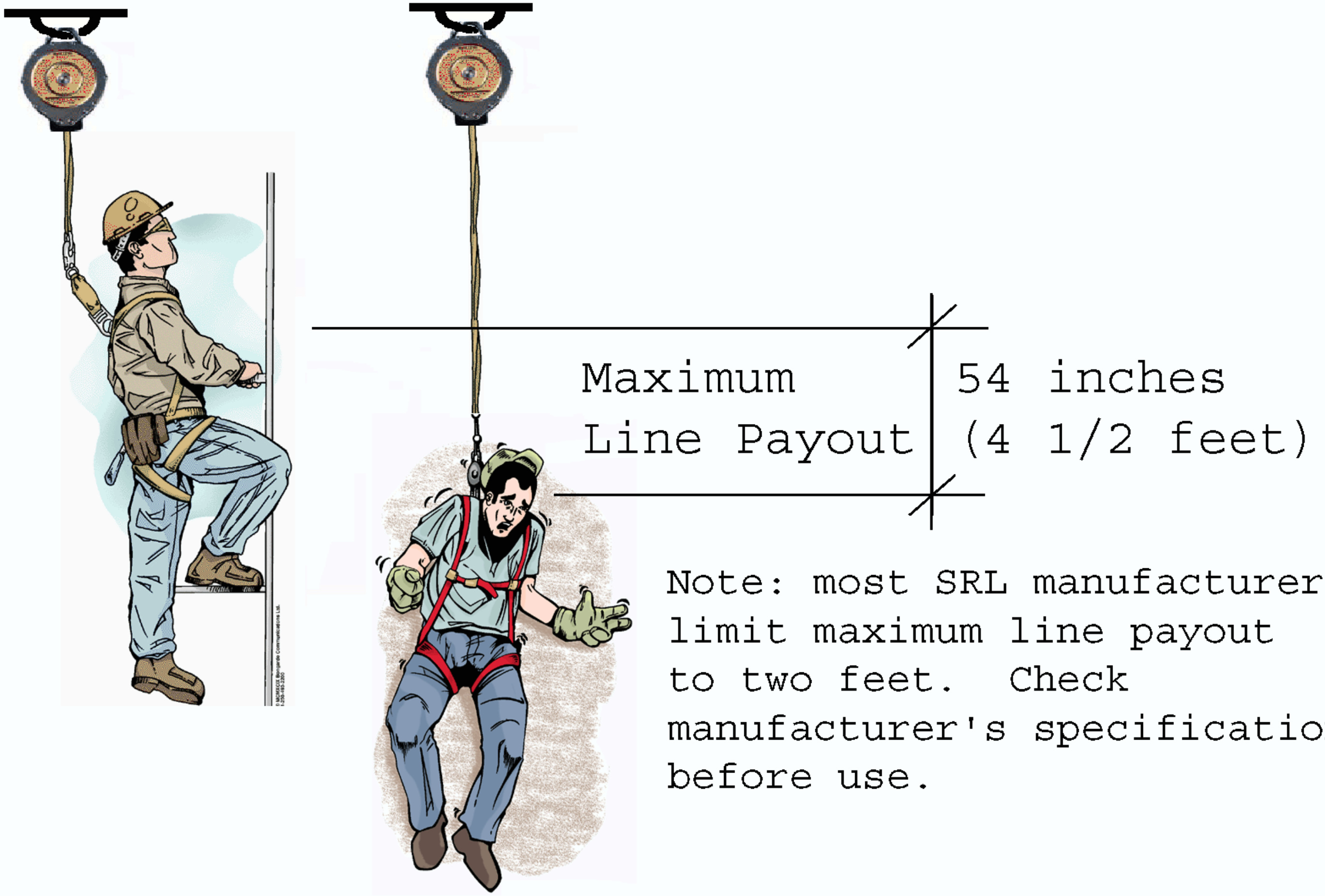
# Fall Clearance - Ladder Climbing Device



# Fall Clearance - Shock Absorbing Lanyard


Lanyard Length
6 feet
Free Fall Distance: 6 feet
Total Fall Distance: 9 1/2 feet
Shock Absorber Deployment
3 1/2 feet
Fall Clearance Required: 17 1/2 feet
Worker Height
6 feet
Safety Buffer
2 feet

# Fall Clearance - Self Retracting Lanyard

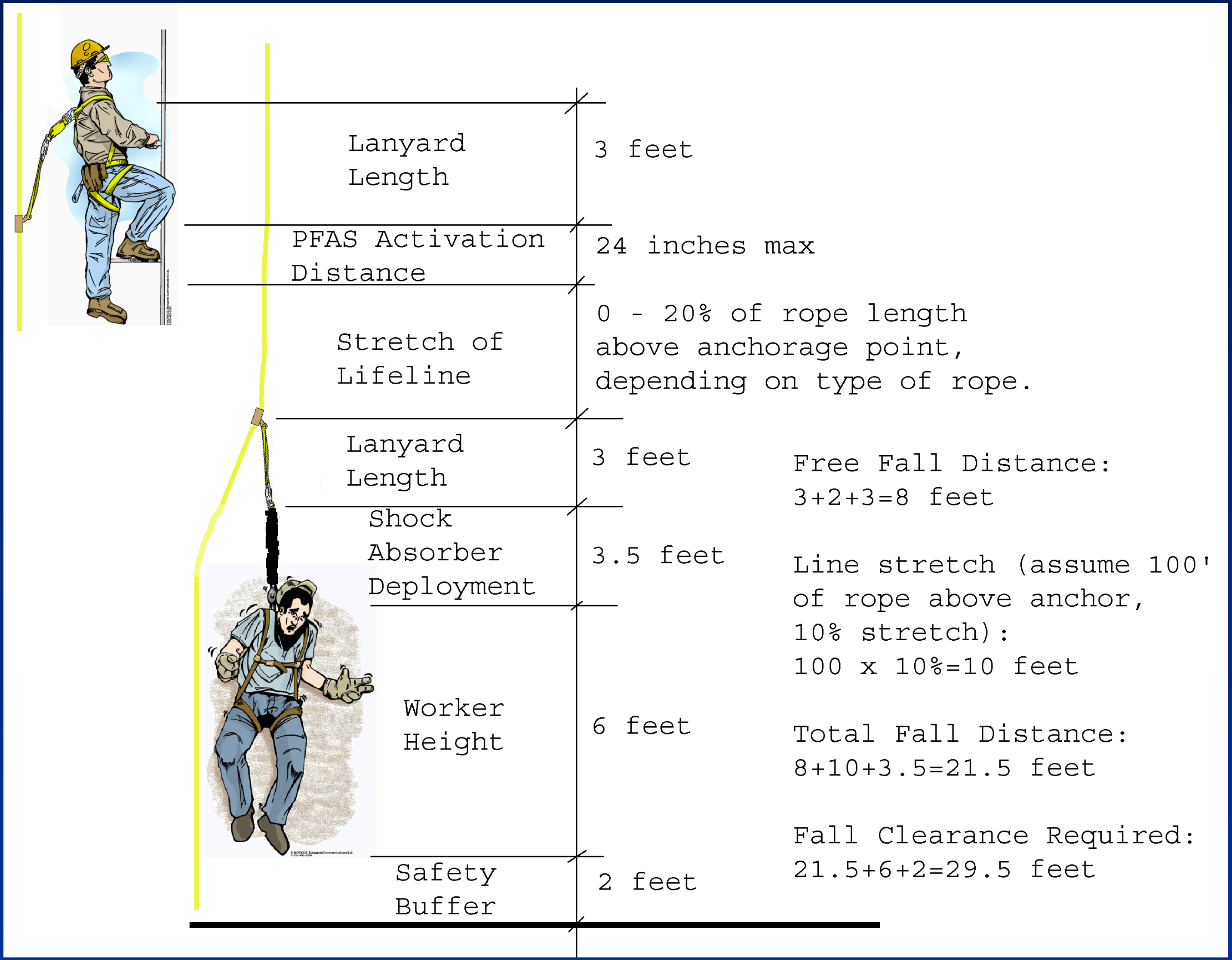


Maximum Line Payout

54 inches (4 1/2 feet)

Note: most SRL manufacturers limit maximum line payout to two feet. Check manufacturer's specifications before use.

# Fall Clearance - Vertical Lifeline



| | |
|---|---|
| Lanyard Length | 3 feet |
| PFAS Activation Distance | 24 inches max |
| Stretch of Lifeline | 0 - 20% of rope length above anchorage point, depending on type of rope. |
| Lanyard Length | 3 feet |
| Shock Absorber Deployment | 3.5 feet |
| Worker Height | 6 feet |
| Safety Buffer | 2 feet |

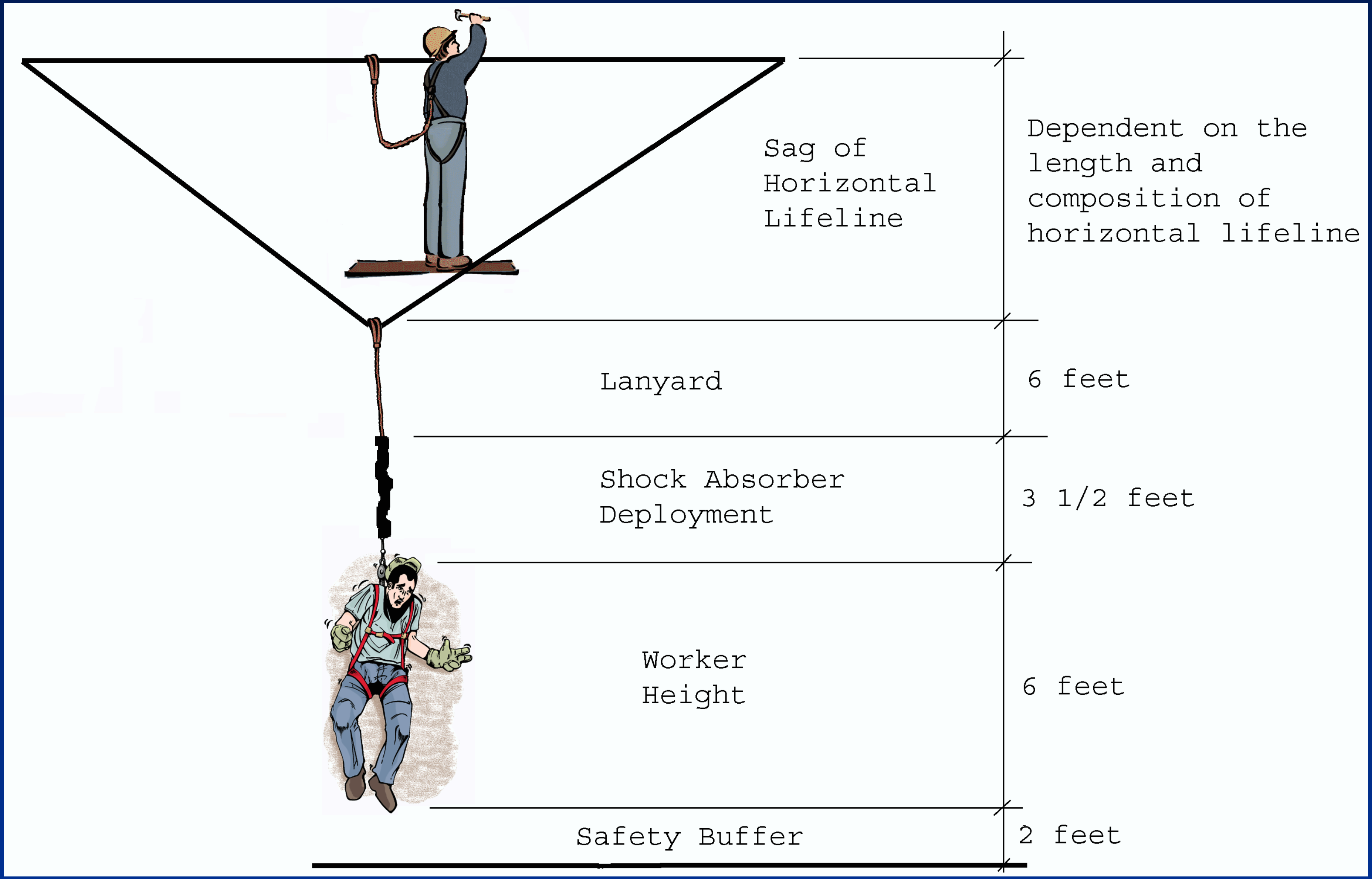
Free Fall Distance:
3+2+3=8 feet

Line stretch (assume 100' of rope above anchor, 10% stretch):
100 x 10%=10 feet

Total Fall Distance:
8+10+3.5=21.5 feet

Fall Clearance Required:
21.5+6+2=29.5 feet

# Fall Clearance - Horizontal Lifeline

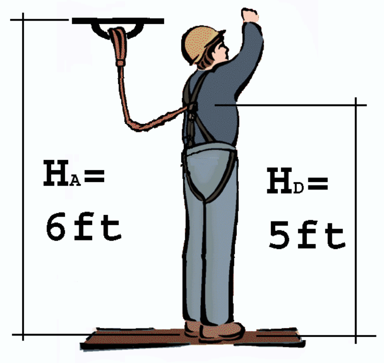


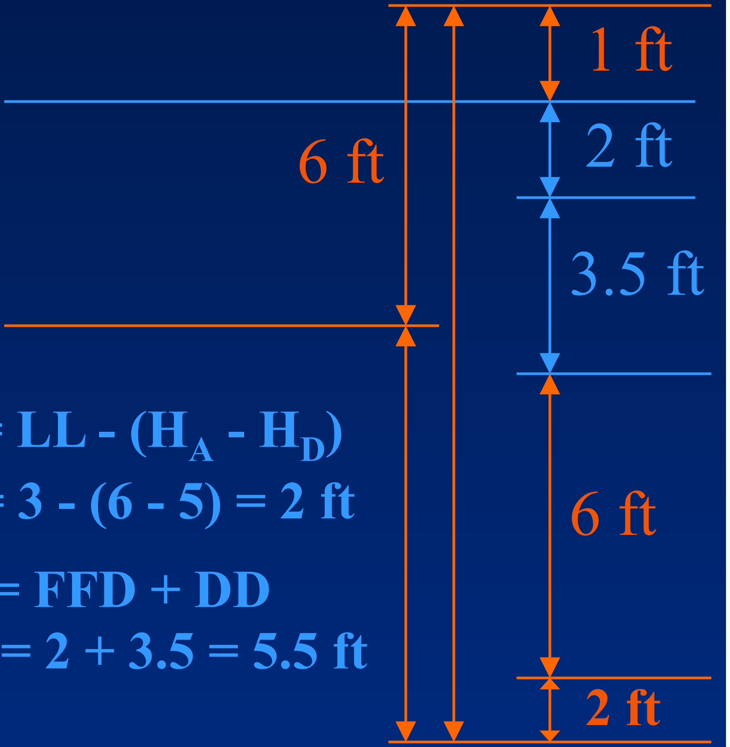
Sag of Horizontal Lifeline
Dependent on the length and composition of horizontal lifeline
Lanyard
6 feet
Shock Absorber Deployment
3 1/2 feet
Worker Height
6 feet
Safety Buffer
2 feet

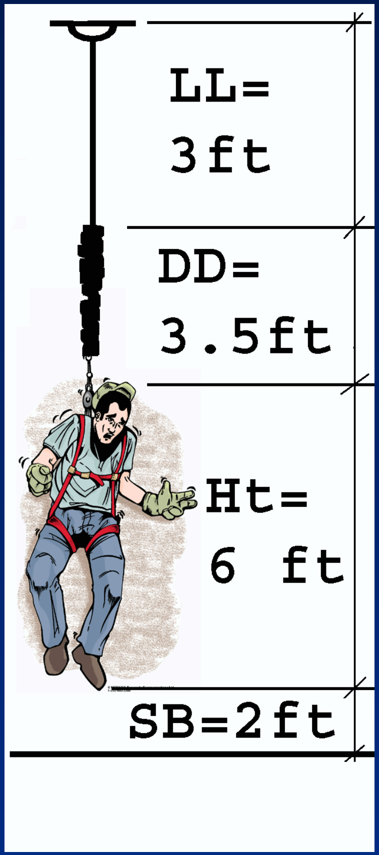
# Fall Clearance – Problem #1

Tom is changing light bulbs in the warehouse. He is standing on a platform that does not have guardrails. He is using a full body harness and a 3-ft energy absorbing fixed length lanyard (deceleration distance = 3.5 ft, stretch in the system = 0). His anchorage Point is located 6 feet above the platform. Calculate the free fall distance. Calculate the total fall distance. If Tom is 6′ tall, calculate the required clearance below the platform for this system to be effective (safety buffer = 2 ft).

# Fall Clearance - Answer #1







Free Fall Dist (FFD) = LL - ($H_A$ - $H_D$)
= 3 - (6 - 5) = 2 ft

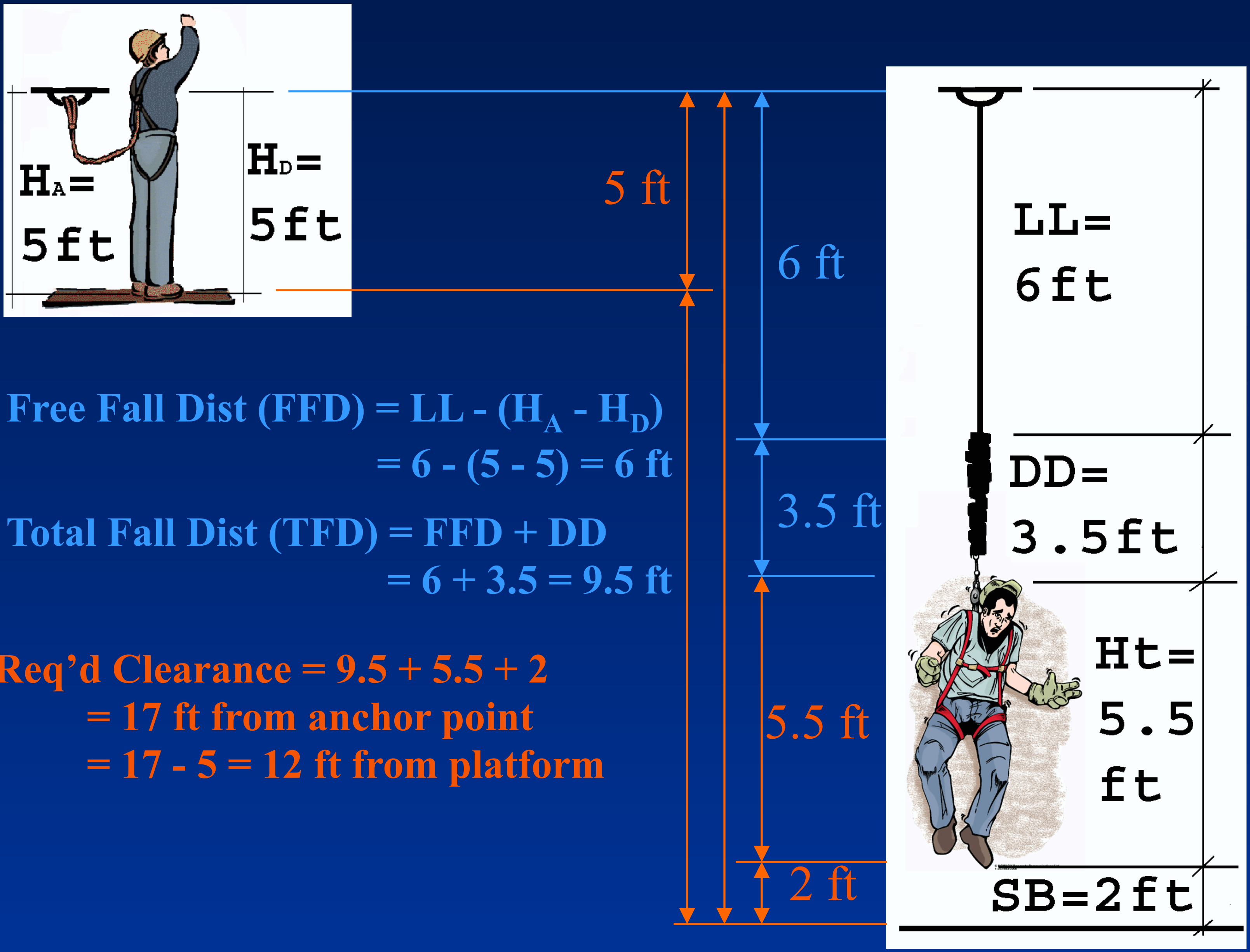
Total Fall Dist (TFD) = FFD + DD
= 2 + 3.5 = 5.5 ft

**Required Fall Clearance = 5.5 + 6 + 2 + 1**
**= 14.5 ft from anchor point**
**= 14.5 - 6 = 8.5 ft from platform**

# Fall Clearance – Problem #2

Sandy is changing light bulbs in the warehouse. She is standing on a platform that is 15 feet above the warehouse floor. It does not have guardrails. She is using a full body harness and a 6 ft energy absorbing lanyard (DD=3.5 ft, VEL=0). Her anchorage point is located at 5-feet above the platform. Calculate the free fall distance. Calculate the total fall distance. If Sandy is 5′ 6″ tall, calculate the required clearance below the platform for this system to be effective (safety buffer = 2 ft).

# Fall Clearance – Answer #2



Free Fall Dist (FFD) = LL - ($H_A$ - $H_D$)
= 6 - (5 - 5) = 6 ft

Total Fall Dist (TFD) = FFD + DD
= 6 + 3.5 = 9.5 ft

Req'd Clearance = 9.5 + 5.5 + 2
= 17 ft from anchor point
= 17 - 5 = 12 ft from platform

# Deceleration Distances

- ANSI states a max of 3.5 ft, activation range of 450 lb to 900 lb
- Assume full deployment in a fall to determine fall clearances
- If shock absorber “bottoms out”, arrest forces can quickly rise above 1800 lb.

# Deceleration Distances

- Actual deployment distance according to:

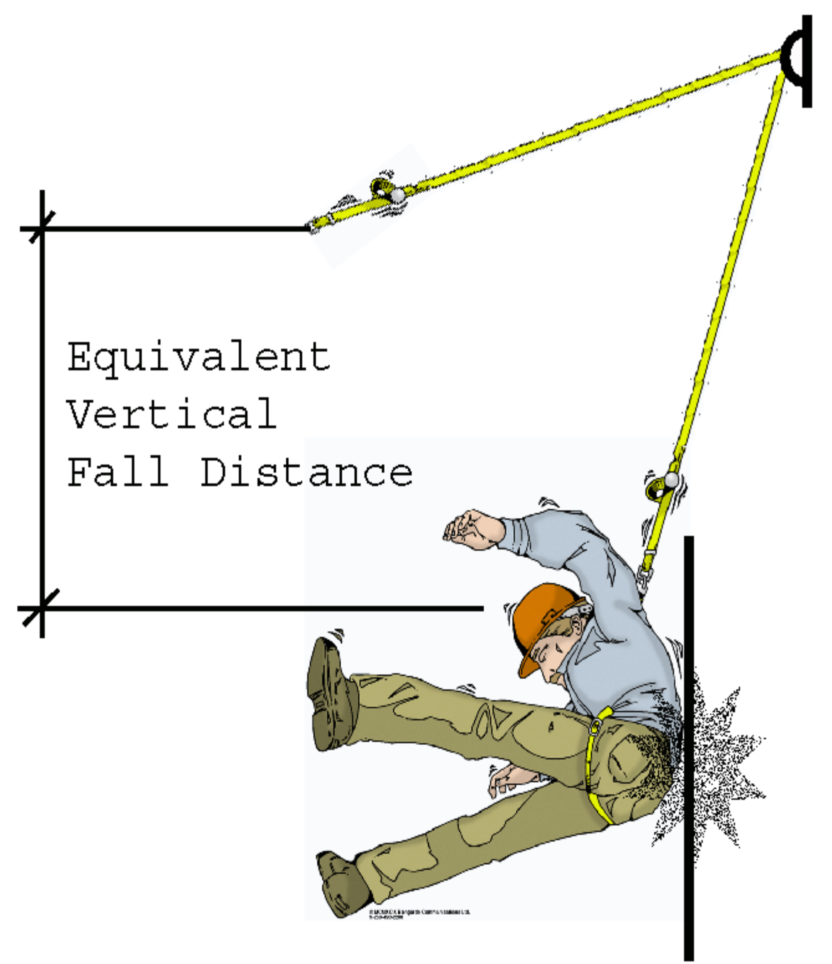
$$DD = \frac{(W/1.4) \times h}{(F_{PEA} - (W/1.4))}$$

Where: DD = Deceleration Distance
W = Wt of worker + tools
1.4 = force factor
h = height of free fall
$F_{PEA}$ = Deployment Force

- If the worker weighs 200 lb and falls 6 ft with a deployment force of 600 lbs (average deployment force for lanyards), DD = 1’ 11”.
- If the worker weighs 310 lb and falls 10 ft with a deployment force of 600 lb, DD = 5’ 10”. Must limit free fall to 6’ to limit DD to 3’6”.
- Note the lower the deployment force (ie - the impact forces) is, the higher the deceleration distance, and the higher the required fall clearance is.

# Swing Falls

- The force of impact from a swing fall is equal to the force of the equivalent vertical fall distance, but the force is not on the feet, and usually not well distributed.



# Arresting Force

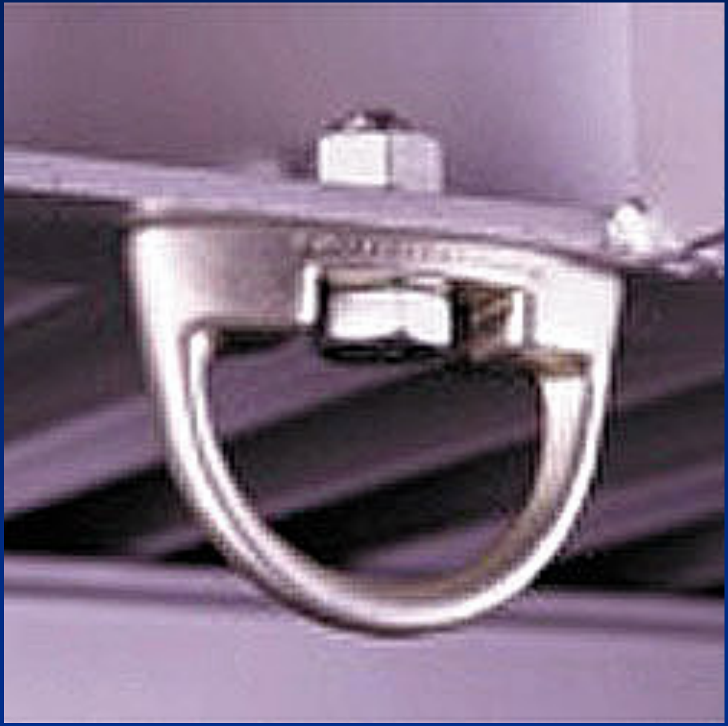
- Maximum Arresting Force
  - Force on the body caused by stopping a fall
  - Maximum is 1,800 pounds by law (OSHA)
  - Threshold for significant injury = 2,700 lb of arresting force
- All PPE is designed for a maximum free fall distance of 6 ft and a maximum arresting force of 1,800 pounds.
- Typically, shock absorbing lanyards limit maximum arresting force to 900 pounds.

*YOUR GOAL:*

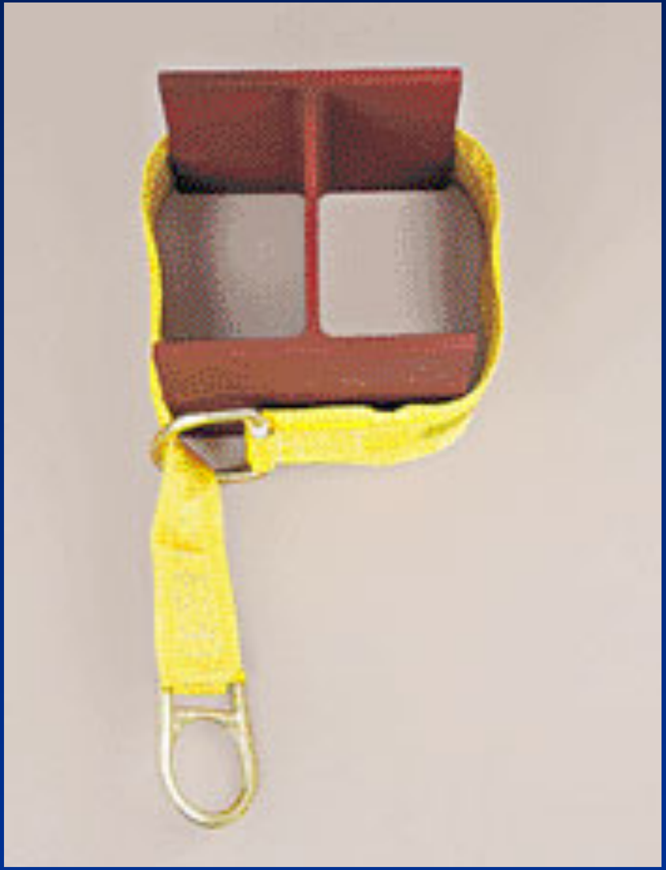
- *Minimize the Free Fall Distance and minimize the Maximum Arresting Force*

# Anchor Points

Engineered



Improvised



# Anchorage Capacity Requirements

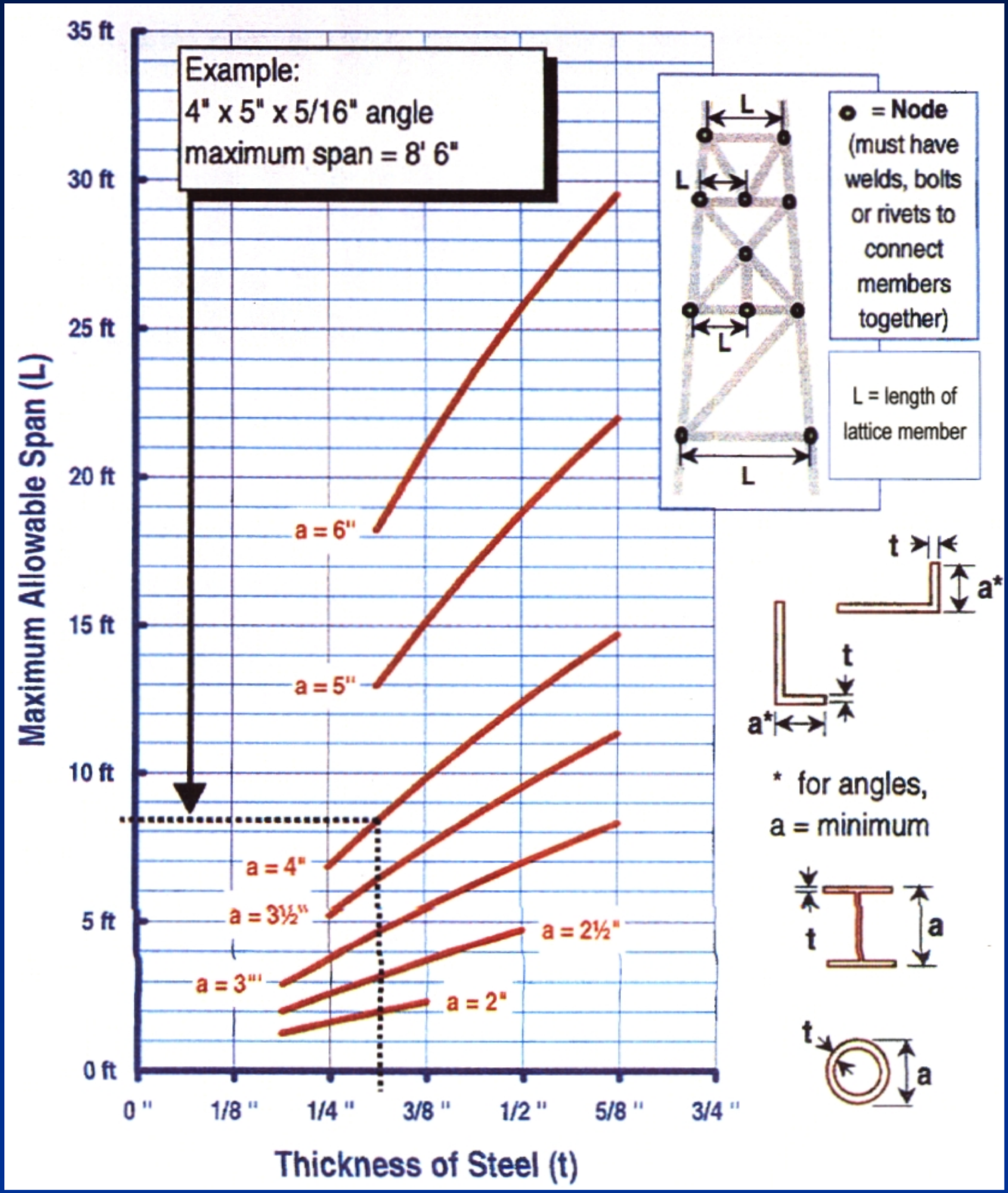
| Equipment | Strength Requirement |
|---|---|
| 3 ft shock absorbing lanyard | 5,000 pounds or 2 times the Maximum Arresting Force (MAF) |
| 6 ft shock absorbing lanyard | 5,000 pounds or 2 times the Maximum Arresting Force (MAF) |
| Self-Retracting Lanyard | 3,000 pounds or 2 times the Maximum Arresting Force (MAF) |
| Vertical Lifeline | 5,000 pounds or 2 times the Maximum Arresting Force (MAF) using 3 ft or shorter lanyard |
| Horizontal Lifeline | Minimum of 5,000 pounds or 2 times the Maximum Arresting Force (MAF) |

# Anchor Point Examples

- Example 1: Anchorage point has a strength of 5,000 pounds, what type of PPE can be used?
- Example 2: Anchorage point has a strength of 3,400 pounds, what type of PPE can be used?
- Example 3: PPE has a maximum arresting force (MAF) of 550 pounds, what is the strength requirement for the anchorage point (if reviewed by qualified person)?

# Anchor Points

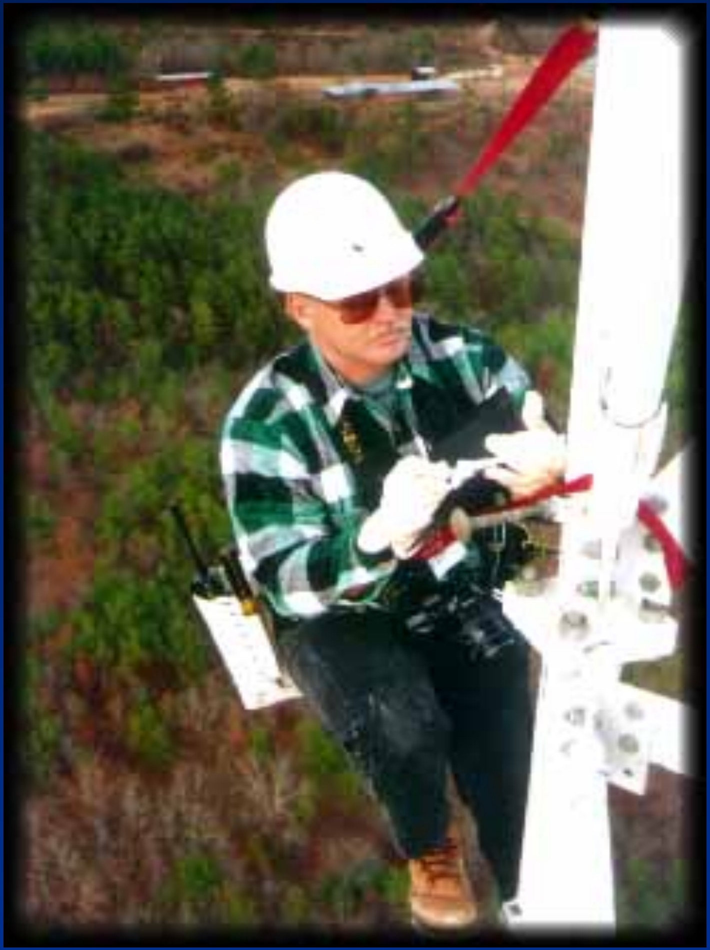
Length and
Thickness of
Steel for use
As Anchor Points



# Review - Stop a fall

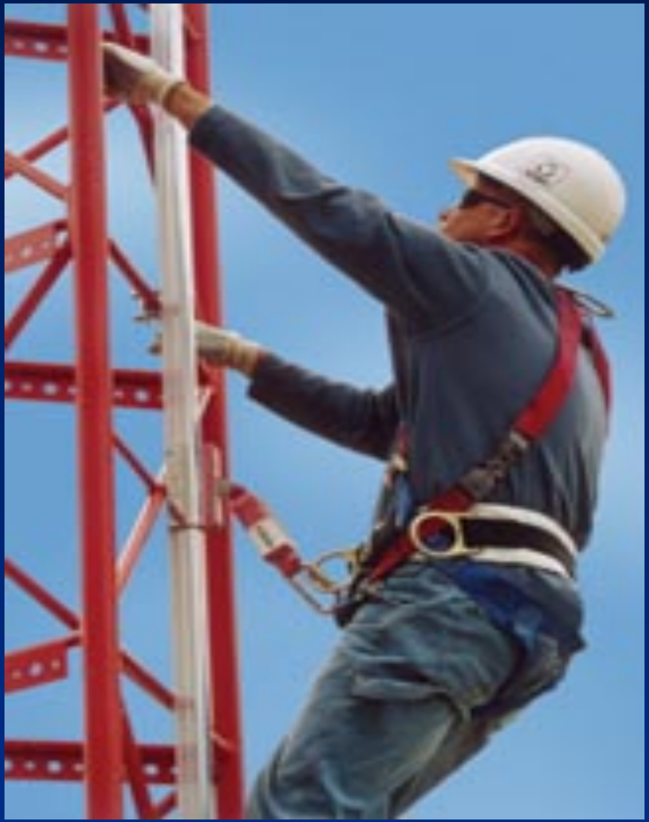
- Use a secondary system
  - Barrier (guardrail, hatch)
  - Fall Restraint
  - Warning system
  - Fall Arrest (ladder safety system, shock absorbing lanyard)
    - Maximum 6 foot free fall
    - Minimum 5000 pound anchor point
    - Maximum 1800 pound arresting force

# Fall Protection Examples



- What is the primary system?
- What is the secondary system?

# Examples



- What is the primary system?
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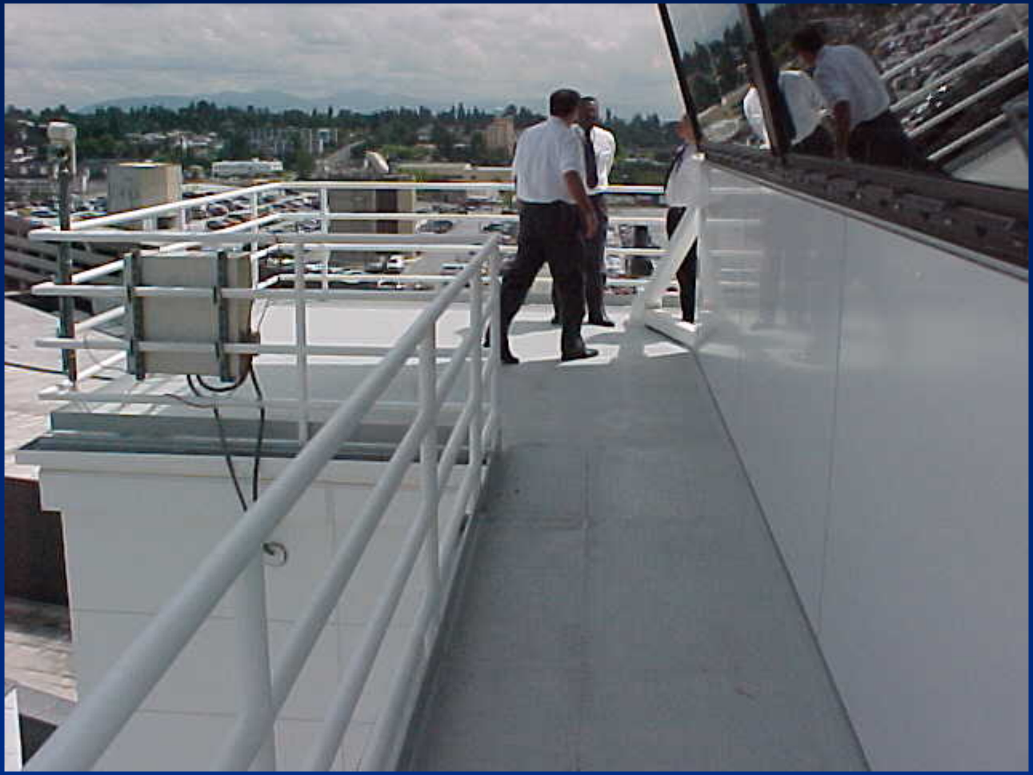
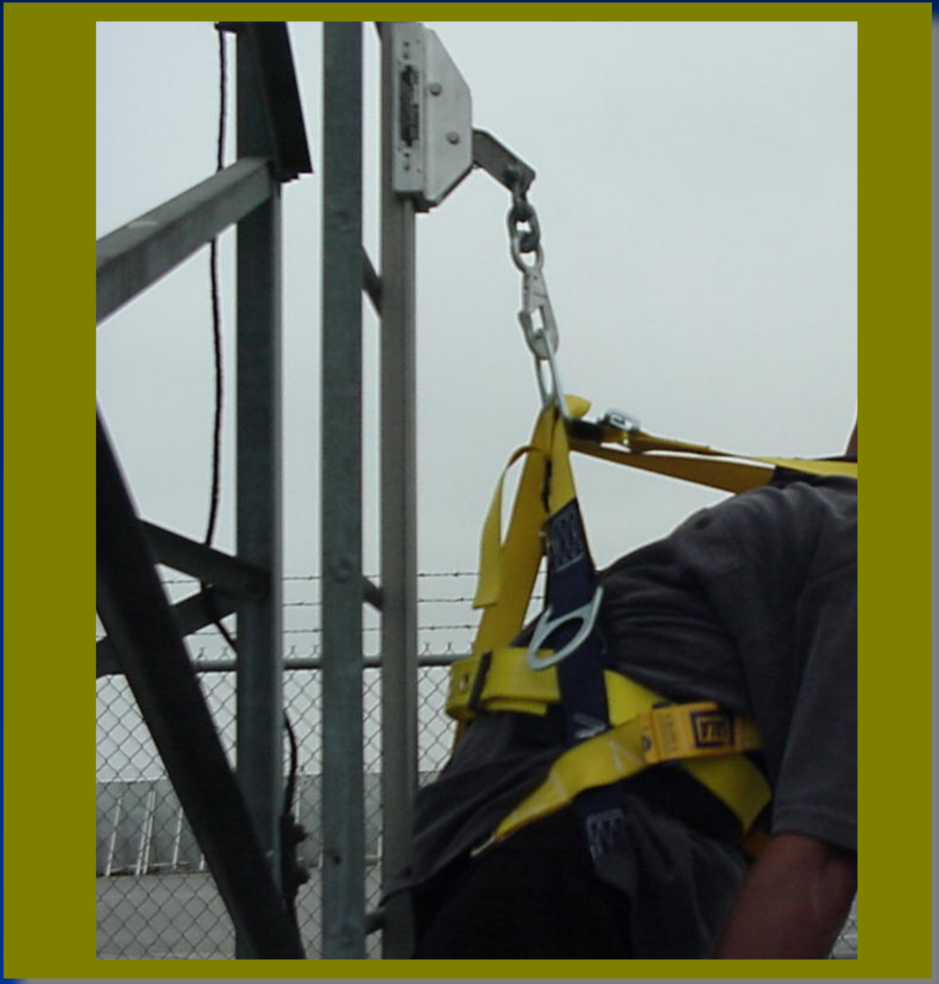
# Examples



- What is the primary system?
- What is the secondary system?

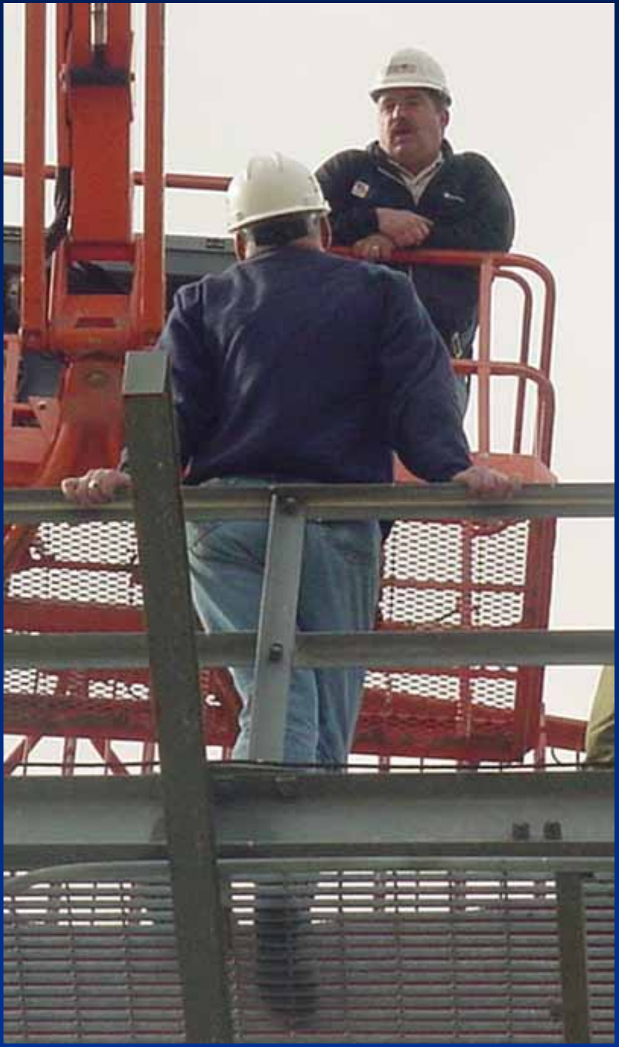
# Examples

- What's wrong with this picture?



# Examples

- What's wrong with this picture?



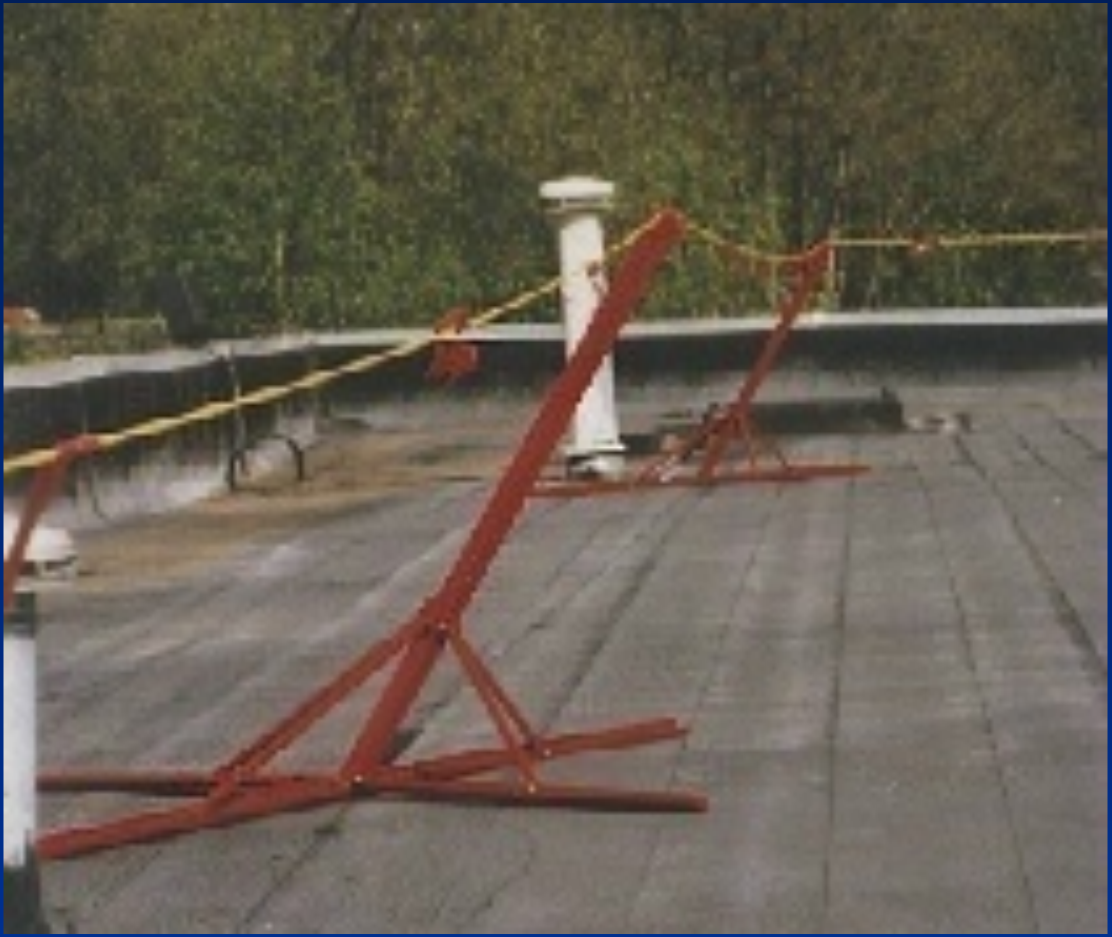
# Review - Get back to ground

- Self Rescue (less than a 2 foot fall)
- Local Rescue Services (confirm availability, response time)
- Rescue (rescue equipment on site)

# Administrative Techniques

# Administrative

## Warning Lines



# Warning Lines

- Only on low slope roofs
- 6 feet back from roof edge
- Around all sides of work area
- Path to work area formed by 2 warning lines
- Between 34” and 39” high
- If working between warning line and roof edge, fall restraint, fall arrest (with rescue plan), or safety monitor system required

# Administrative

## Safety Monitoring System

# Safety Monitoring System

- Full time Safety Monitor:
  - competent to recognize fall hazards
  - has no other duties/responsibilities
  - close enough to see/communicate
- Safety Monitor shall warn employees when it appears they are unaware of a fall hazard
- No employees on roof except those engaged in roofing work

# Administrative

## Written Fall Protection Plan

- Least preferable fall protection option offered by OSHA
- Only available to employees engaged in leading edge work, precast concrete erection, and residential construction
- Not applicable to applications

# Rescue Considerations

# Rescue Considerations

- If potential fall distance is six feet (maximum allowed by OSHA):
  - could end up suspended, out of reach from structure
  - could incur injuries during fall that inhibit climbing down (unconscious, broken limb)
- When hanging in harness, 30 minutes until the onset of health issues due to circulation problems

# Rescue Considerations

- These two considerations lead to three levels of rescue plans:
  1. Self Rescue
  2. Local rescue services available
  3. Trained rescue (Not Covered In This Briefing)

# Self Rescue

- May be used if potential fall distance is limited to two feet or less:
  - no appreciable injuries due to the fall
  - can still reach the structure
- Does not require second person
- Not feasible when using shock absorbing lanyard

# Self Rescue

- Systems that can use self rescue:
  - Fixed ladders with ladder safety systems
  - Platforms with hatches and/or guardrails

# Local Rescue Services Available

- If local rescue available (e.g. fire department) is within a 30 minute response time, they may be used as a rescue plan, provided:
  - Site specific rescue plan is completed and on site
  - Capabilities and availability of local rescue services has been confirmed
  - Second person on site and able to contact rescue services
- Review sample site specific rescue plan

# Trained Rescue

- If the potential fall is greater than two feet and local rescue is not available within 30 minutes:
  - Must have at least 2 workers
  - Workers must be trained in rescue
  - Rescue kit must be on site
  - General rescue plan required.

# Suspension Considerations

- 1972 study - 8 climbers survived suspension period hanging free from 1/2 hour to 8 hours. Rescued alive, but all died between 1/2 hour to 11 days after rescue. Cause found to be **venous pooling**
- Deoxygenated blood collects in the legs during suspension. When suspended victim is rescued, the sudden rush of “bad blood” can cause heart and/or kidney failure.
- Sometimes called “rescue death” - safe rescue, only to have victim die when released from suspension.

# Venous Pooling

- Preventive actions:
  - If suspended, attempt to stand or brace your feet against something.  If this is not possible, move and flex your legs to keep blood moving.
  - If unconscious:
    - When returned to ground, **DO NOT LAY DOWN** or elevate legs.  Seated or crouched position for 20 to 40 minutes.
    - Hospitalize afterwards in case of shock or possible kidney failure.  Travel to hospital in a seated position.

# Rescue-At-Heights Kit

- Example: Not included in scope of this briefing

# Equipment Inspection

# ANSI Z359.1 Requirements

- Equipment shall be inspected by user before every use
- Equipment shall be inspected by a competent person annually
- When inspection reveals defect, equipment must be immediately removed from service
- At a minimum, comply with manufacturer instructions regarding inspection, maintenance and storage

# Equipment Inspection Responsibilities

- As the competent person, you are liable for any accidents/incidents caused by failure of fall protection equipment you’ve inspected, assuming the equipment was being used properly.

# Personal Protective Equipment – Inspection

- What do we inspect for?
  - signs of wear;
  - cut or frayed edges;
  - damaged grommets;
  - burns;
  - broken stitches;
  - distorted snap hooks;
  - loose or distorted rivets;
  - impact indicators

# Points of Inspection

- Labels
- Fabric Components
- Stitching
- Metal Components
- Plastic Components

# Labels

- Required on:
  - Harnesses
  - Lanyards (with and without energy absorbers
  - SRL's (Self Retracting Lanyards)
  - Lifelines (vertical and horizontal
  - Anchorage connectors
- Are they legible?
- Do they state equipment meets ANSI Z359.1?
- Where applicable, are punch grids current?

# Labels

- Note: There is no shelf life on fall protection equipment - if the equipment passes the inspection, it can still be used. Additional labels can be purchased when originals have been used.

# Fabric Components

- Check for:
  - Signs of excessive wear (fraying, weakened fibers)
  - Cut or frayed edges (more than 1/4” deep)
  - Discoloration (burns, chemical deposits, mildew, etc)
  - Stiff/hardened fabric (heat, paint, chemicals, etc.)
- Only mark with a Sharpie or Marks-a-lot marker

# Stitching

- Check for:
  - Broken or pulled stitches (if 2 or more broken stitches on any load bearing part of the equipment, it should be retired - be sure to differentiate between pulled stitches and thread termination)
  - Unraveled strap tips (strap could slide through buckles)

# Metal Components

- D-rings - check with hands, feel for any deformities or changes in diameter
- Buckles - check for crushing, sharp edges, or other deformities
- Grommets or rivets - check for damaged, distorted, or loose (elongated grommets could indicate the equipment has seen a freefall)

# Snaphooks

- Ensure the design has a self-closing, self-locking gate
- Check that the gate and gate lock don’t stick open
- Check for hook and eye distortions
- Checks for cracks (especially aluminum components) or corrosion
- Remove any screw-gate carabiners from service

# Plastic Components

- Check for torn or melted areas.
- Plastic components are not usually load bearing, so deficiencies are not usually urgent.

# Personal Protective Equipment – Inspection

- Manufacturer's Inspection Forms
  - Model Number
  - Serial Number
  - Inspector
  - Inspection Date
  - Date Made is Date of Manufacture
  - Disposition – left until last after inspection is complete
  - Inspection Points

# Inspection Forms

- MSA
- DBI
- Other?
- Not required for personal use, however…
- Keeping a Use Log is a GOOD IDEA!

# Inspection Points of Full Body Harness

- Fabric Parts
  - Webbing
  - Stitching
- Metallic Parts
  - D-Rings/Oval Rings
  - Buckles/Adjusters/Grommets
- Plastic Parts
  - Back D-ring Locator
  - Strap Collar
  - Labels
  - Tool Belt Support Clips

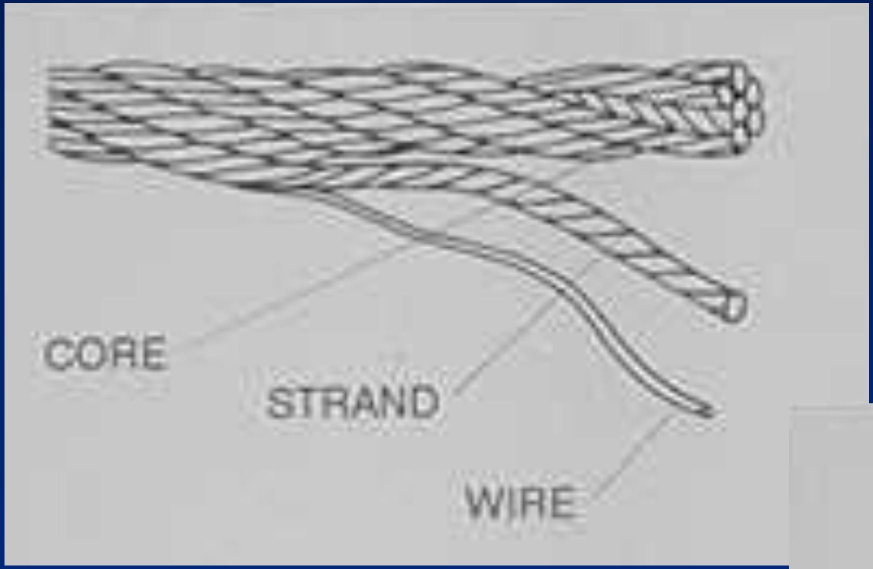
# Inspection Points of Lanyard

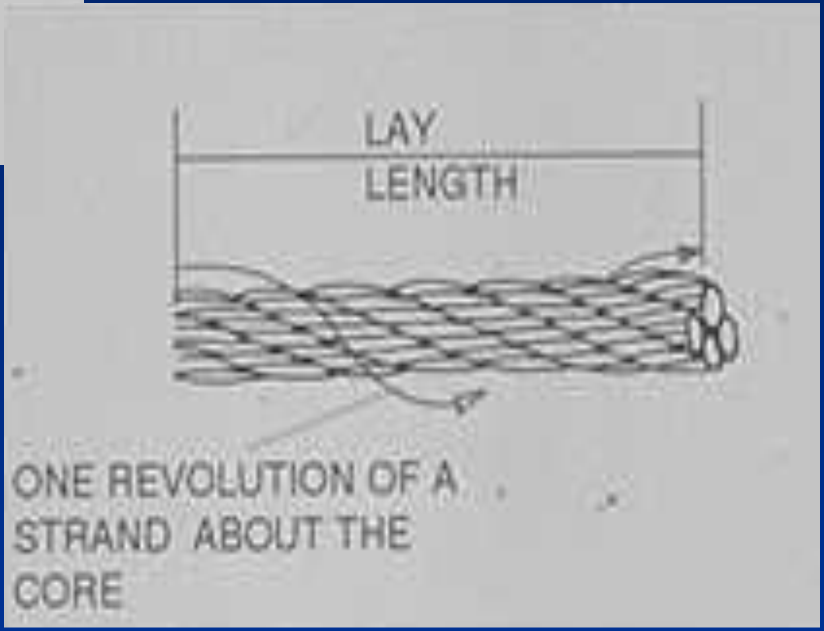
- Fabric Parts
  - Webbing
  - Stitching
  - Shock absorber
  - Impact indicator (if applicable)
- Metallic Parts
  - Snaphooks

# Inspection Points of an SRL

- Check the casing for cracks or severe dents, and ensure the labeling is legible
- Check the snaphook for damage and proper operation
- Check the cable - does it move smoothly and evenly? The entire cable must be pulled out and inspected for broken wires.
  - If there are any broken strands or wires within 1" of the farrell, then the SRL must be taken out of service. If you have 3 or more wires in any one strand in any one lay, OR, 6 or more wires in all strands in one lay, are broken – it must be taken out of service.

# Inspection Points of an SRL





# Personal Protective Equipment – Inspection and Maintenance

- What are the typical failures of equipment that you've seen?
- Let's look at some examples….

# PPE Inspection

- Inspect your equipment before each use
- Remove questionable equipment from service for Competent Person inspection.
- Equipment must have been formally inspected within the past year
  - Stored equipment does not require annual inspection, but must be formally inspected before use

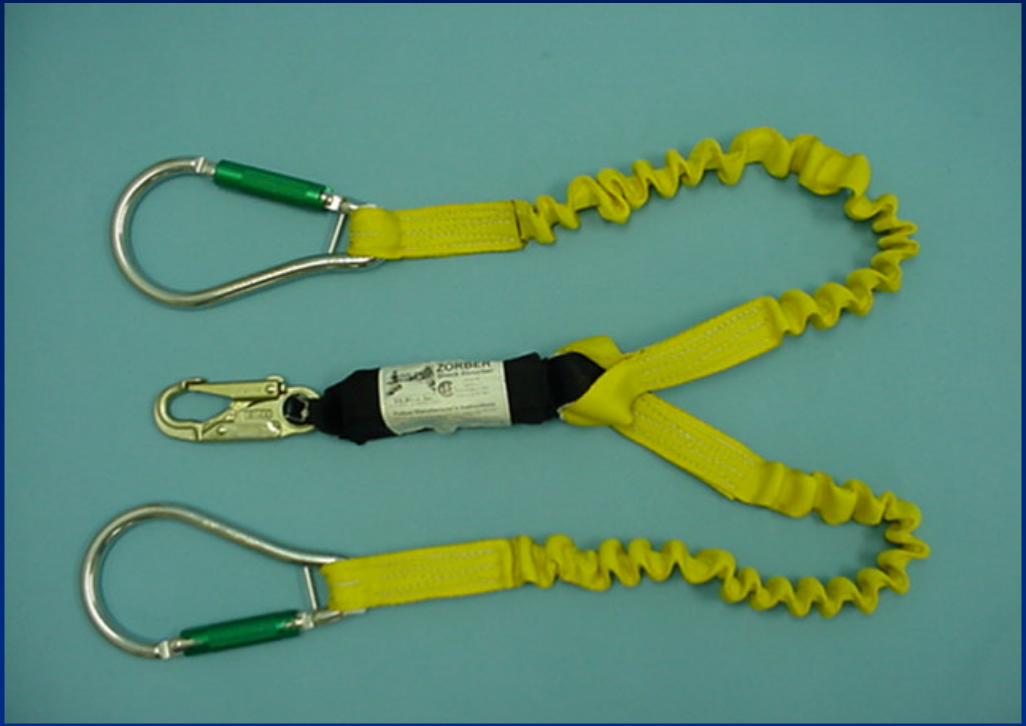
# PPE Inspection

- Formal inspection must be performed by a competent person other than the user.
- Equipment used in installation and demolition activities must be formally inspected every six months.
- Formal inspections must be documented
- Immediately retire equipment that has been subjected to the forces of arresting a fall

# Harness Inspection

- Webbing
- D-Rings
- Grommets
- Buckles
- Tags

# Lanyard Inspection



- Webbing
- Shock Absorbers
- Snaphooks
- Tags

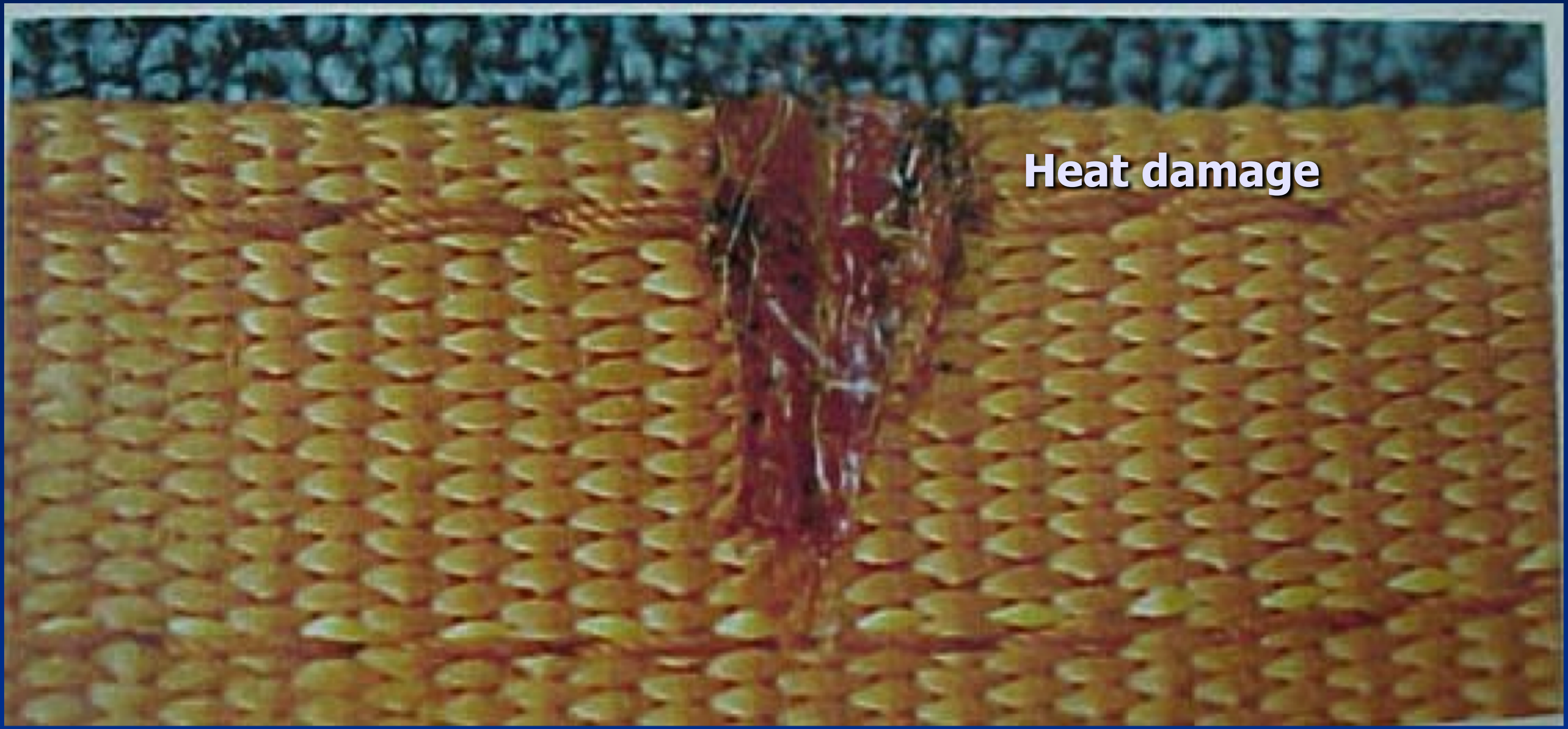
# Work Positioning Device Inspection

- Webbing/Rope
- Snap hooks

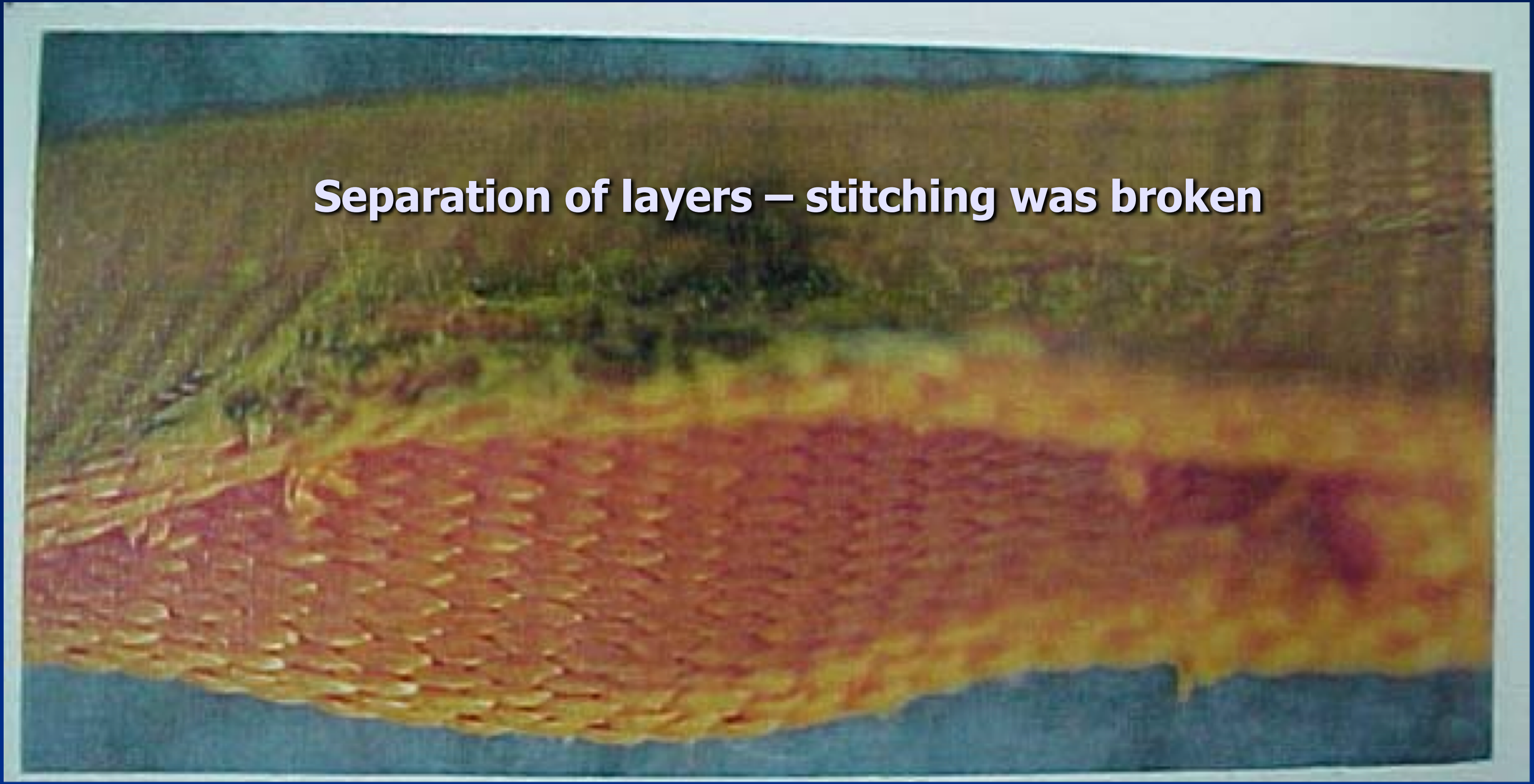
# Storage of Equipment

- Cool dry place
- Out of sunlight
- If wet, hang until dry

# Examples of PPE Failures

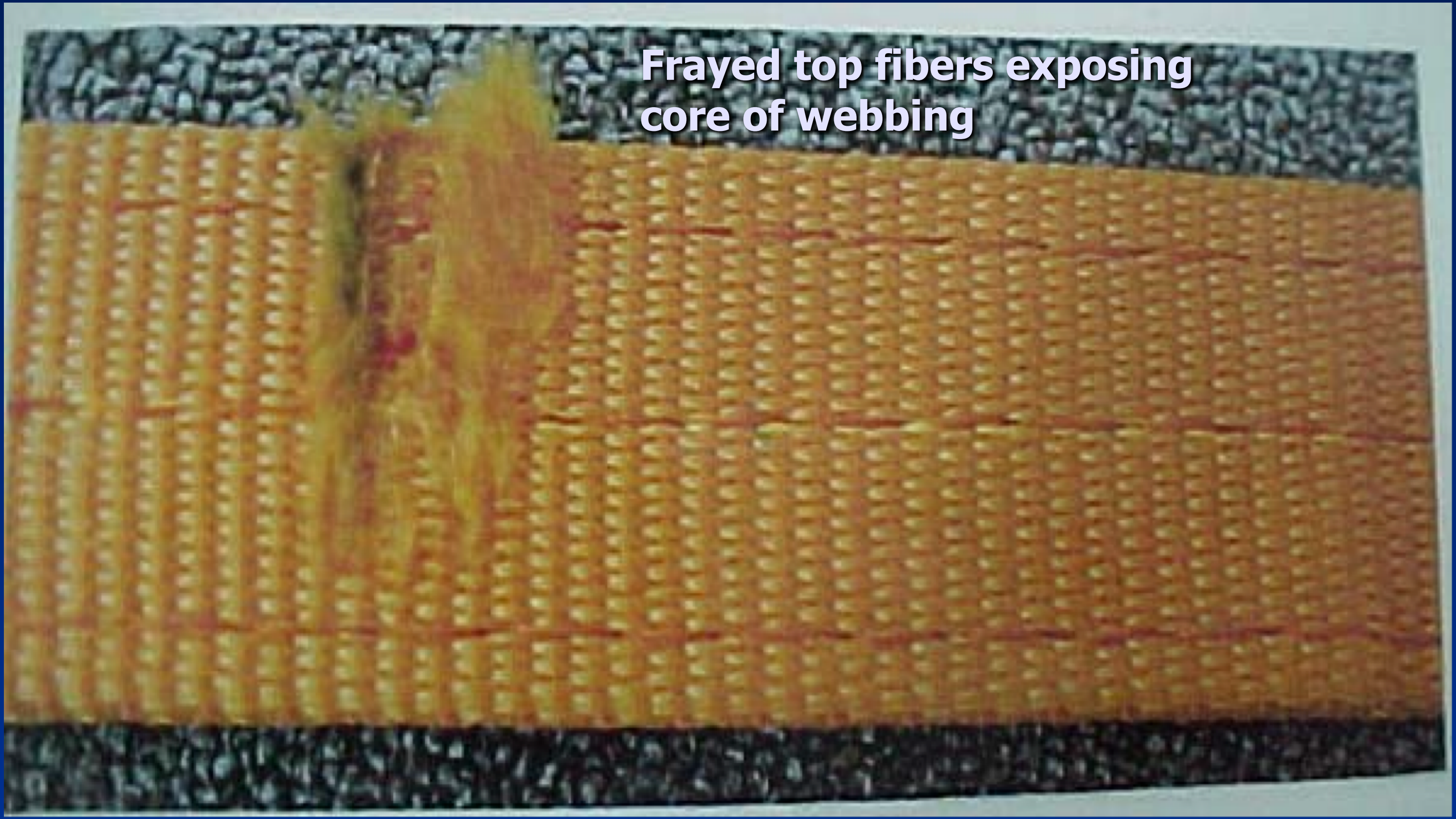


# Examples of PPE Failures



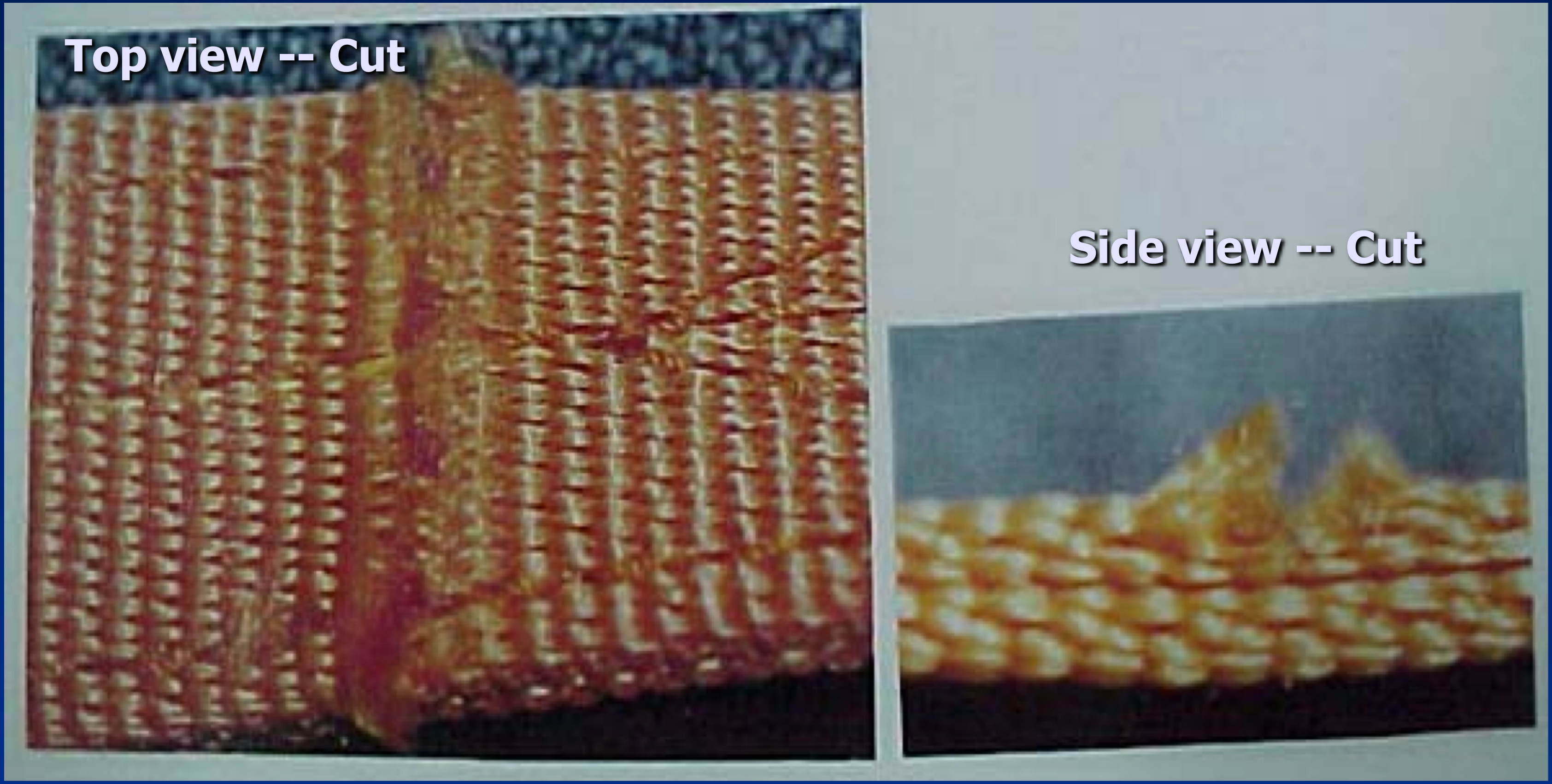
Separation of layers – stitching was broken

# Examples of PPE Failures



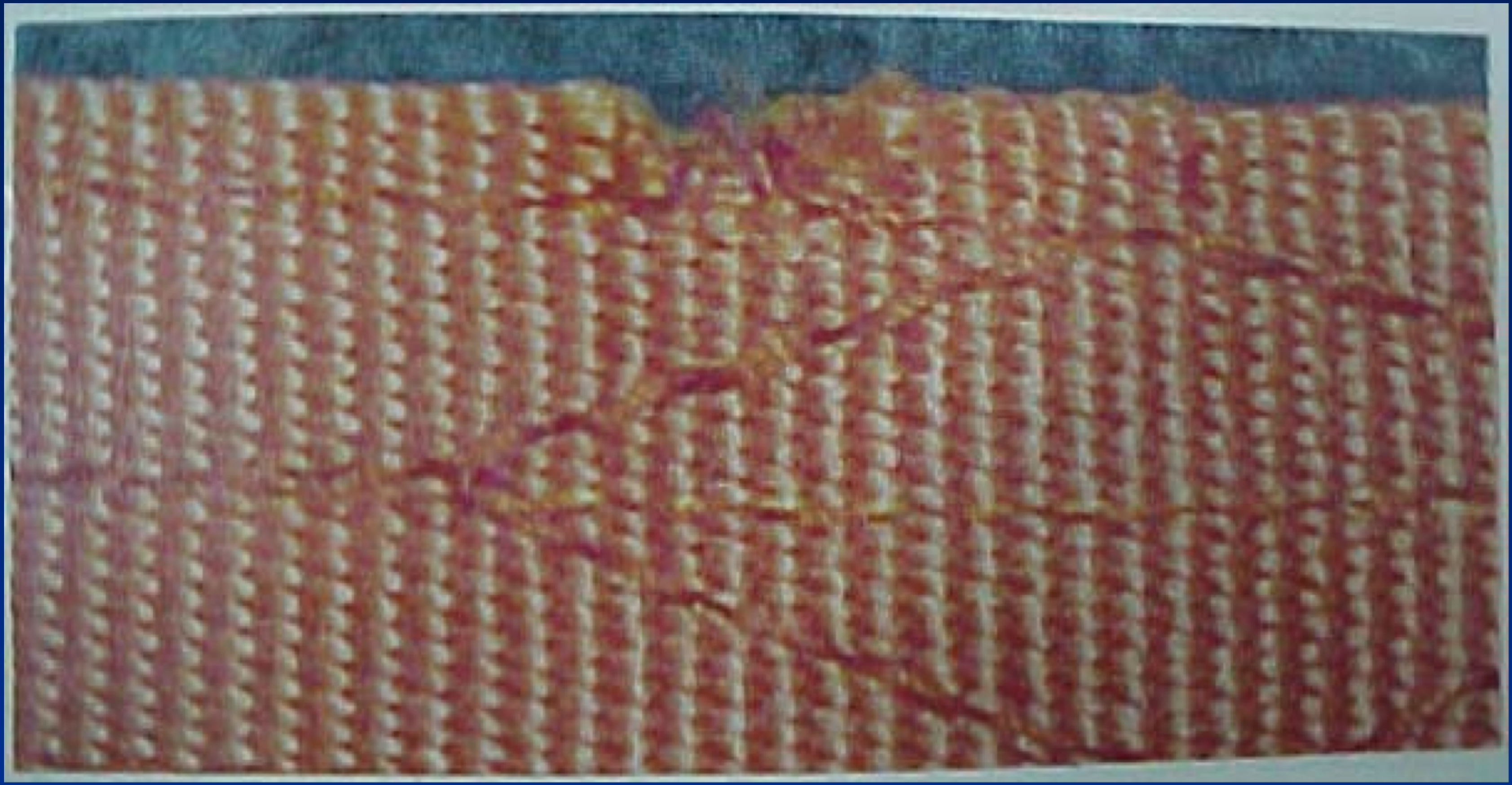
Frayed top fibers exposing core of webbing

# Examples of PPE Failures

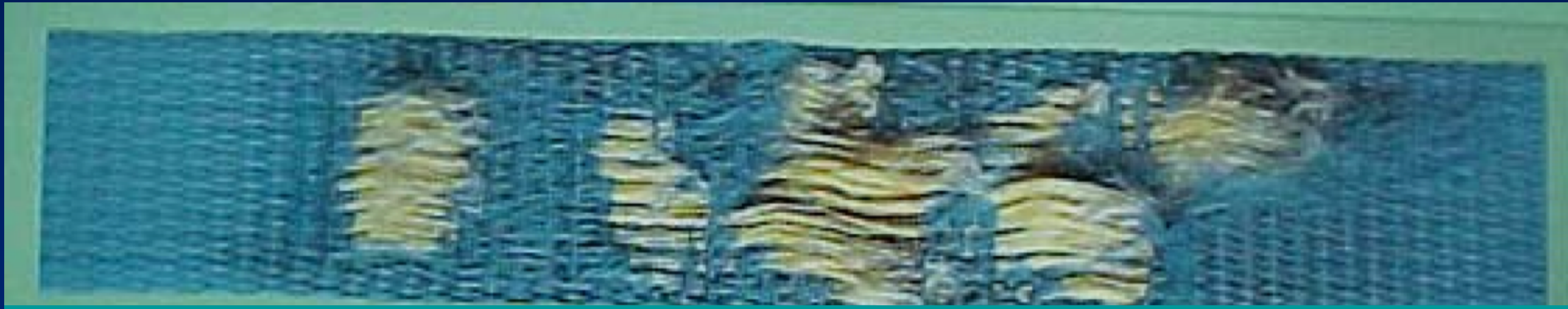


# Examples of PPE Failures

Damage due to cut



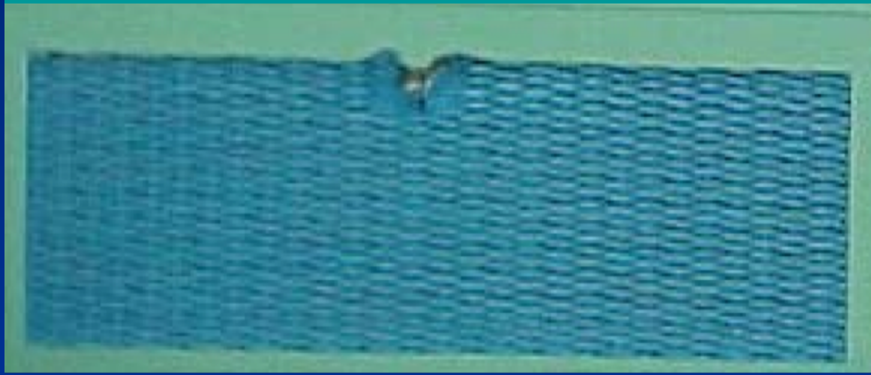
# Examples of PPE Failures



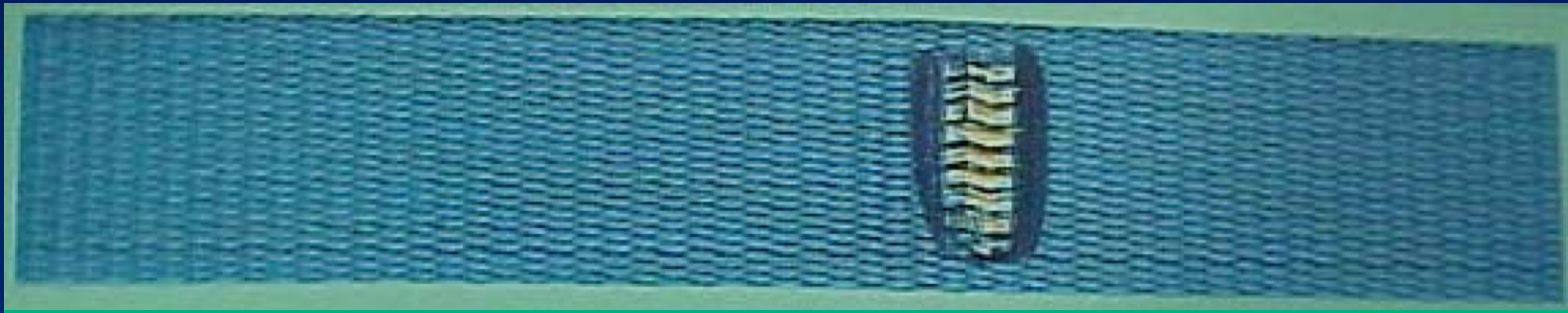
Reinforced inside fiber is exposed due to wear

Inside fiber exposed due to cut

Inside fiber exposed due to cut

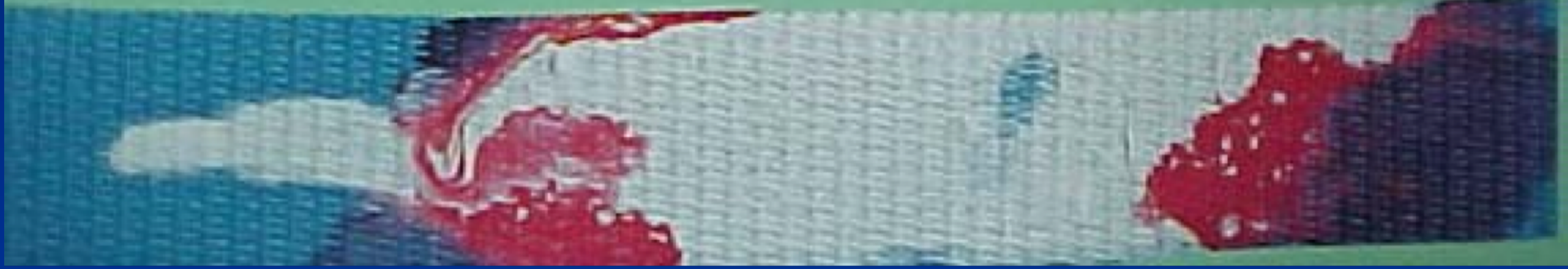


# Examples of PPE Failures

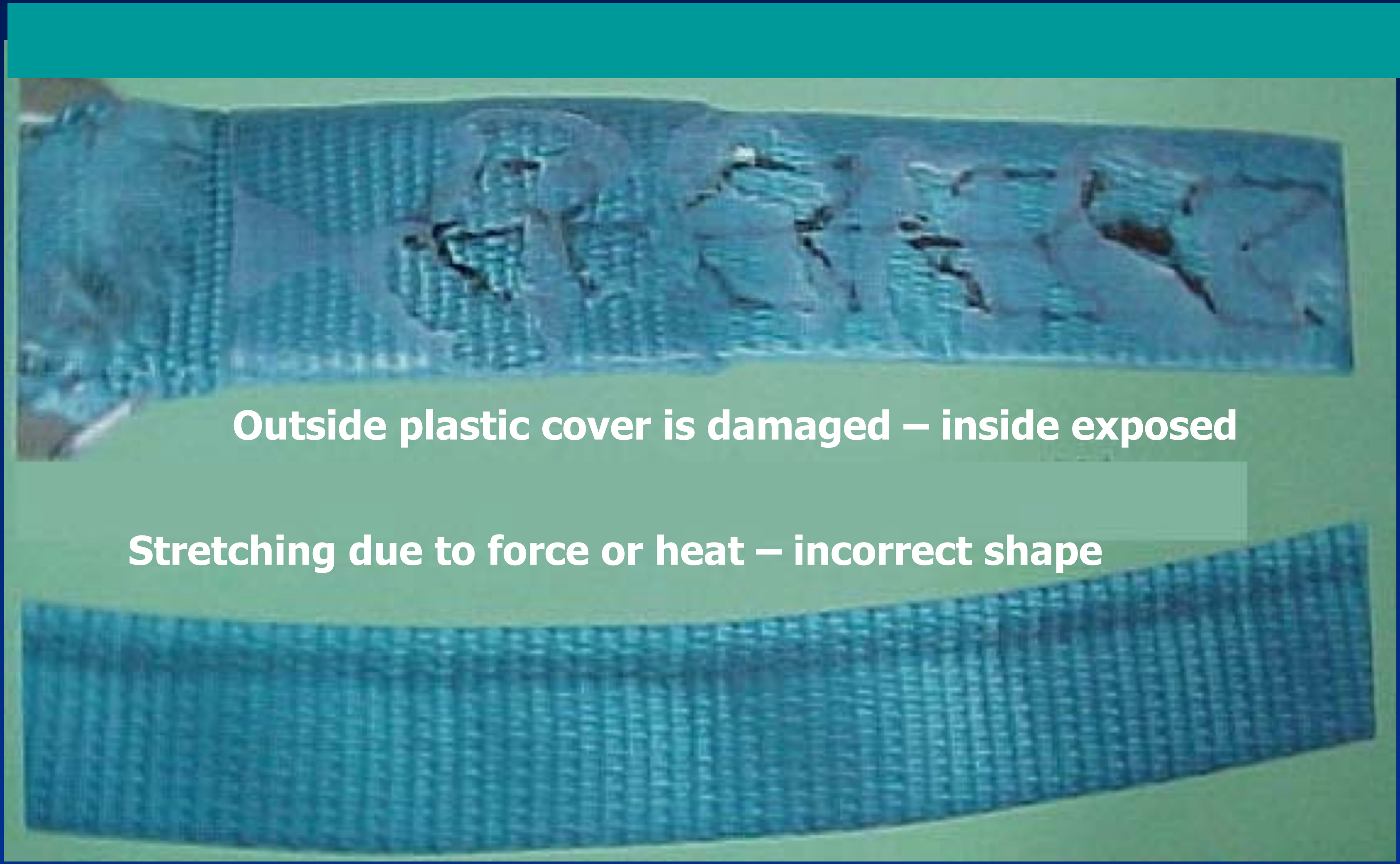


Damage due to heat – inside fiber exposed

Hardened surface due to exposure to paint



# Examples of PPE Failures



Outside plastic cover is damaged – inside exposed

Stretching due to force or heat – incorrect shape

# Equipment Inspection

- Inspection Schedule
- Documentation
- Disposal of failed equipment
- Acquiring new/replacement equipment

# Cleaning/Storage

- Clean and store according to manufacturer’s instructions
- Cleaning – mild soap and cold water; hang to dry
- Storage – out of the sunlight (sunlight degrades the fibers)
- Ensure equipment is dry before storing

# Fall Protection Exercise

- Identify some fall protection issues
- Develop some solutions
- List the positive characteristics and negative characteristics for your solutions

# Review

- OSHA Standards
  - 1910 - General Industry
  - 1926 - Construction Industry
- Fall Hazard scenarios have options (Hierarchy of Controls)
  - Hazard Elimination
  - Fall Prevention
  - Fall Protection
  - Administrative techniques

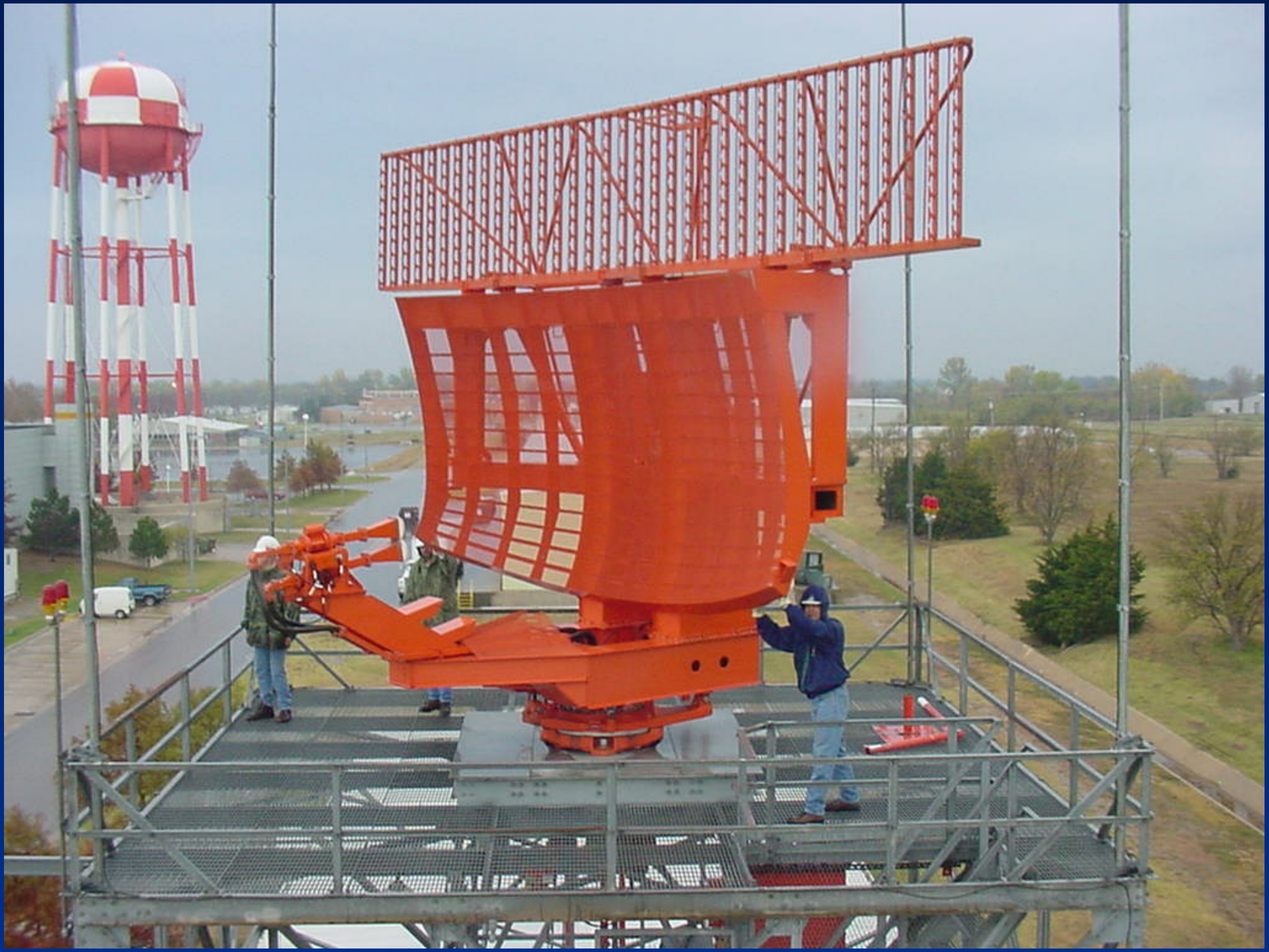
# Review

- Choose which solution works best for your work situation
- Fall Prevention:
  - Guardrails/hatches/covers
  - Personnel Lifts
  - Fall Restraint Systems

# Thanks For Hanging Around!

- www.commacademy.org
- www.ww7mst.org

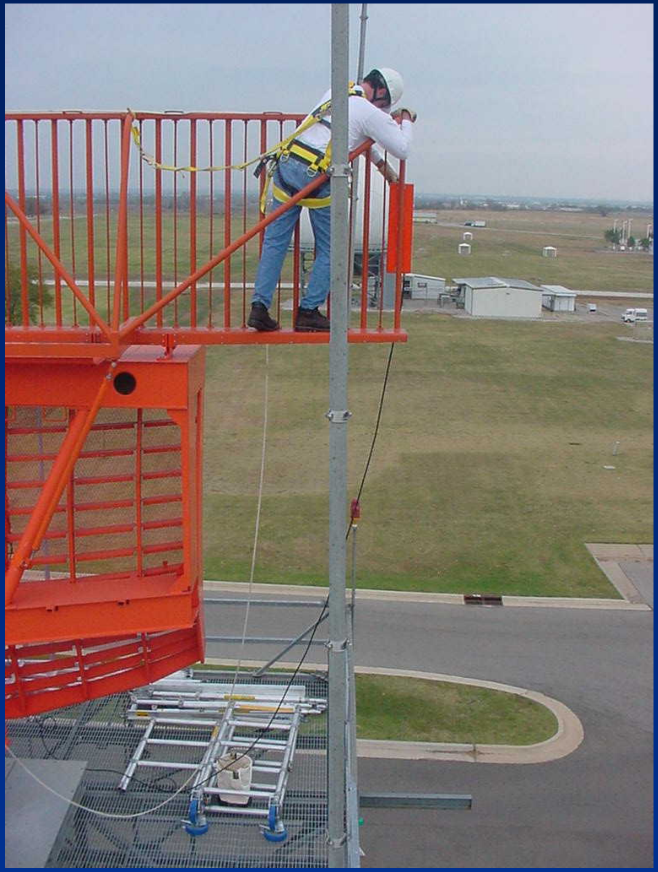
# Work Example: ASR-9



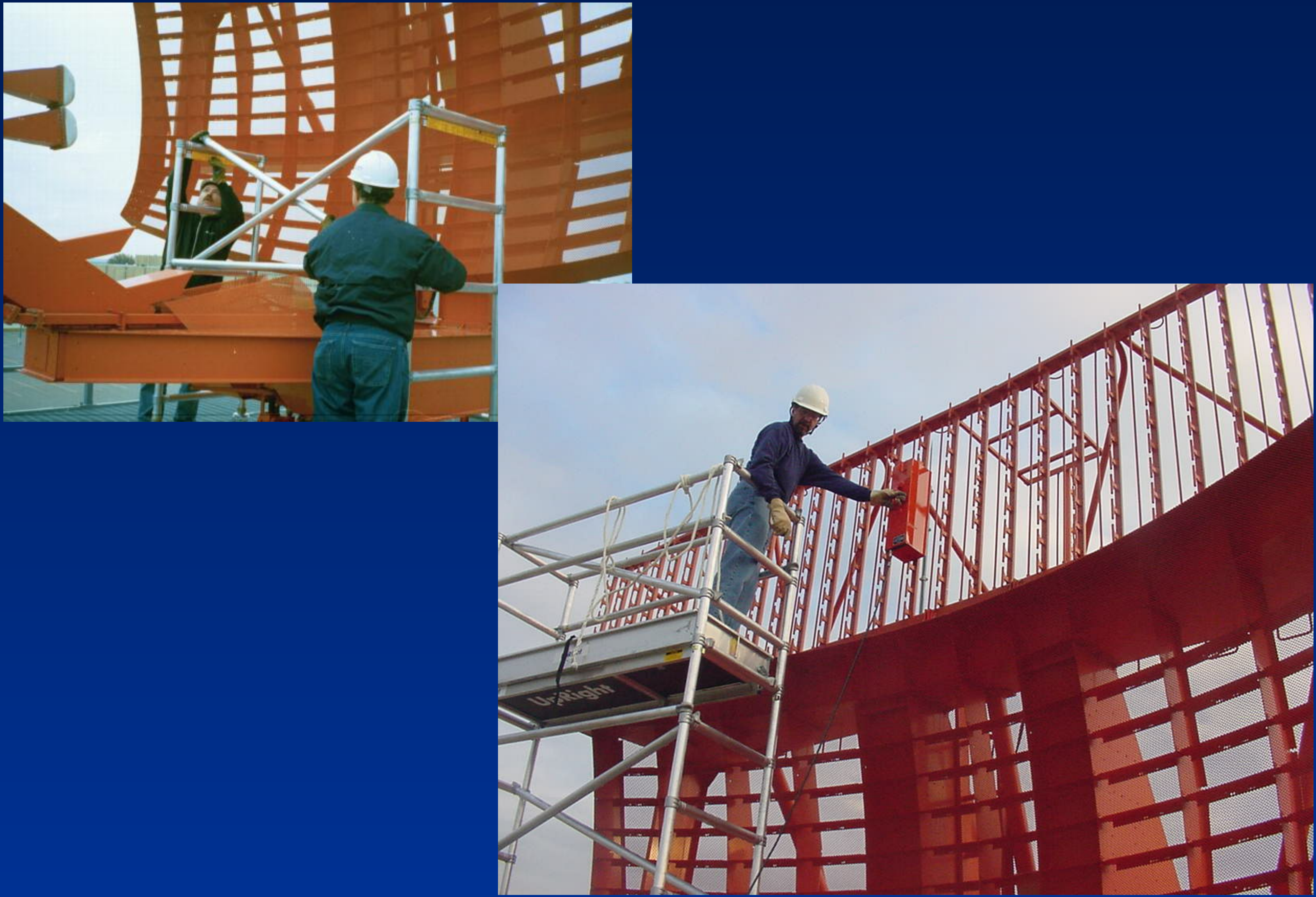
What are the fall protection issues?

# ASR-9

- Must take power readings from elements
- No available anchor points have sufficient capacity



# Possible solutions - Scaffolding



# Possible solutions - Aerial Lift

# Possible solutions - Telescoping Probe Box